# THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS

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*Second Edition*


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# PREFACE

Revision of the first edition of this monograph on posture and its disturbances became imperative with the added interest and opportunities of study afforded by military demands of World War II Twenty three million men were carefully processed physically and those considered fit were subjected to tremendous bodily hardships The natural question followed, raised by leaders in anthropology medicine and physical education to wit what kind of man was able "to take it." Thus posture came into a proper focus since without man's unique stance this survival would not have been possible As a result, numerous postural studies of the military man and woman enable students of this basic factor of life to reach more penetrating conclusions.

The authors equipped by training in associated fields of inquiry physical education physical anthropology orthopedics and physical rehabilitation, having allied their interests and research, combined to produce practical methods of analysis and treatment of postural disturbances.

Chapter I has been revised in the light of Simpson's quantum evolutionary hypothesis yet retaining much of Morton's original ideas. That man did not of necessity require a tremendously long period of time for his postural adaptations now seems feasible. Greater advances in growth studies of children of all ages psychobiological research as related to posture and new effective trends in physical education, are drawn upon throughout the revision. New classifications of posture and its disturbances are proposed, based upon ages of occurrence and correlated with new methods of determining body types. Treatment of abnormal variations are suggested, that may be applied by those most concerned. While parents will find much of the material pertinent, those primarily interested are the physician the teacher at all school levels, the physical educator and the modern athletic coach.

Questions have been raised with a few answers propounded.

Yet any inquiry which does not raise more questions than are answered, is less than effective. In that sense, the authors are hopeful that they have "spurred the minds of men" with their efforts, and that some who read will not only apply what may be applicable, but will also advance new proposals leading to further investigations of posture.

Without man's posture, no man without man, no culture- without culture, a world not worth the living therein.

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# THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS

CHAPTER I

# EVOLUTIONARY INFLUENCES ON THE POSTURE OF MAN

**Property of all Matter** No force in the development of life on earth is of greater consequence than the force of gravity For untold millions of years all matter organic and inorganic alike, has been influenced by it obeying its law But gravity is more than that. It is also a basic natural phenomenon in the make-up of every living thing, wherever and whatever it may be. When combined with the demands of locomotion the design of animals becomes meaningful. This is sometimes called streamlining

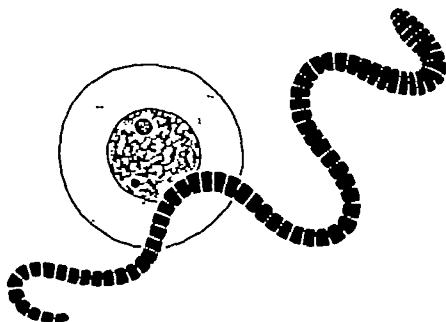


Figure 1. An early single celled form of life- fluid contained by a restraining membrane globular in shape. The lowly earth worm, streamlined and efficient, able to survive at least two billion years. Shape and locomotion are governed by environmental requirements

**Earliest Medium of Life.** Far back in the depth of time water which covered the earth became the home of the first living organisms They were minute masses of protoplasm surrounded by a delicate cell wall. Since the specific gravity of water and protoplasm is about the same, the frail cell walls were not subjected to much strain The identity of these simple and earliest organisms was preserved.

**Earliest Shapes of Living Units.** Their shapes were roughly spherical and their aquatic environment made an ideal nursery for the beginning of progressive evolutionary changes As animal motility developed, the spherical form evolved to a tapered cylindrical body coinciding with the direction of movement. Propulsion through the water was accomplished by means of undulating movements

**Earliest Vertebrates.** From these simple spineless creatures there evolved ever so slowly probably over a period of a billion years, the far less simple vertebrates who each could boast a backbone. A variety of paddlelike fins and rudders plus a head and a tail, were attached to a spinal column. Such adaptations were ob-

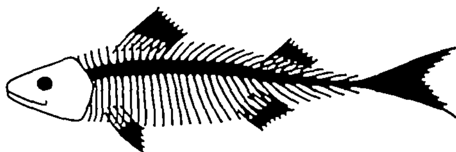


Figure 2. Early vertebrate form, a standard fish, streamlined and efficient.

viously satisfactory as the enormous number and varieties of water living creatures attest Fins and rudders acting as balancers, although fragile in character were adequate organs of propulsion

**Amphibians—Reptiles.** The earliest shore visiting creatures were weak of limb and clumsy of movement. They could not lift their bodies off the ground but had to drag themselves about in a

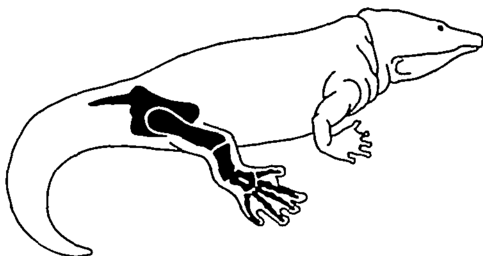


Figure 3 Shallow landlocked pools required extremities for slithering in mud to stay alive Earliest amphibian forms developed specialized legs and feet.

tedious, helpless way Limbs developed to allow these creatures to propel themselves from pool to pool and over muddy flats and dry areas as their environment changed. Later among the truly amphibious forms the appendicular skeleton acquired definite characteristics During subsequent ages of time when reptiles

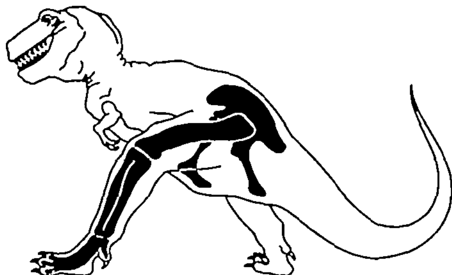


Figure 4 Eventually terrestrial reptiles grew to enormous sizes, especially regarding their hind legs, used for walking in and out of swamps.

were the dominating type of animal life these organs of locomotion became powerful Some developed toes and some claws Their feet were adapted to support them as they lumbered about in the ooze and mud. Such feet were complicated, with many more bones than was later found necessary They were bulky and neither quick nor easy to use for possible defense. Their heavy tails however were excellent weapons as well as organs of equilibrium Snakes are examples of land forms that reversed this adaptive process They lost their various appendages and returned to a state of limbless existence They specialized in undulating movements while retaining their cylindrical bodies.

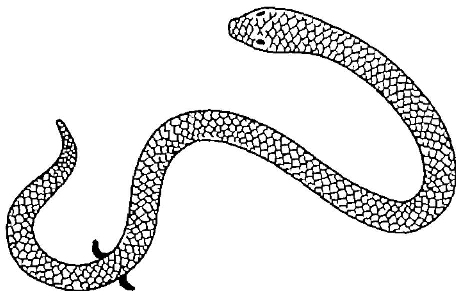


Figure 5 The boa constrictor a reptilian form that retrogressed formerly had four extremities but today only retains two minute thigh, vestigial structures.

Birds. Out of this reptilian family developed birds with their highly appropriate wings for flight, and bipedal weight bearing feet. The latter are equipped with claws for scratching and clinging or grasping A tail appeared as an organ of locomotion and balance when in flight. One extinct bird family retained its scales but by and by all birds grew feathers instead of scales Birds of today are remarkably well suited to their environment.

**Stages of Adaptation** The long course of evolution from the ear liest land forms of life to modern man can be represented as passing through the following stages the *amphibian reptilian the reptilian mammal the primitive mammalian* or warm blooded

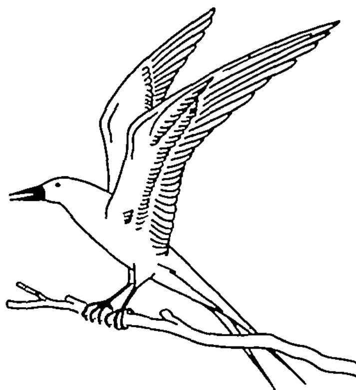


Figure 6 Bipedal bird form showing perfect adaptation to environment.

animals and the *primates* the great group of mammals with which man is usually classified These latter also include lemurs and tarsoids *arboreal quadrupeds* ancient and modern anthropoids represented by the old and new world monkeys *arboreal quadrupeds* and baboons *terrestrial quadrupeds* as well as gibbons *arboreal bipeds* together with the orangutan chimpanzee and gorilla, *cursory terrestrial bipeds*

**Posture of Primates.** Most of these latter primates may be considered part time terrestrial bipeds, however preferring to move

along on all fours When on the ground, they compare with man in many anatomical and physiological adaptations On the other hand, man s posture and locomotion represent distinct departures from the rank and file of other land animals Doubtless, the human upright carriage of the body has been derived from the

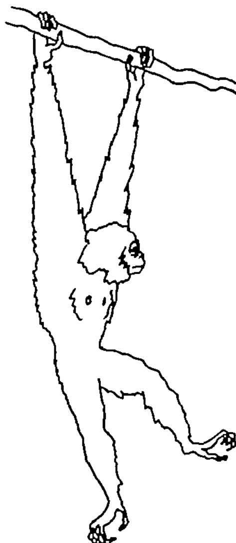


Figure 7 Gibbon, an excellent brachiator who can also run upright in a reasonably satisfactory manner Is a tree liver by preference.

horizontal posture of the ancient quadruped But the change has not been acquired through stages of semi-erectness such as may be observed occasionally among the larger anthropoid apes Evidence points clearly to the vertical adaptation of man s body as a rapid development, beginning as a mutation and taking place during the early half of the period since the primate stock came into being During this time span the prehuman and other an

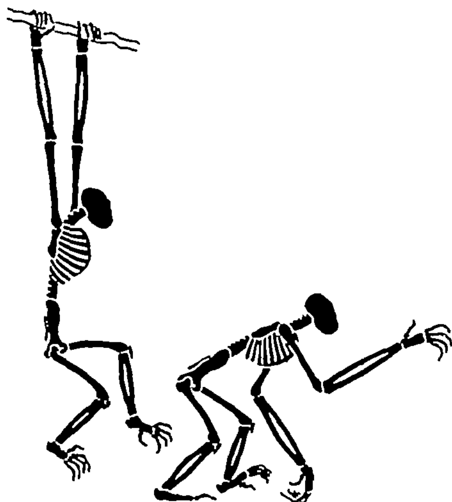


Figure 8 a) Chimpanzee, also a good climber and a fair brachiator who prefers a quadrupedal form of progression. Brachiating environment prepared the chimpanzee for quasi-bipedalism only Note long upper extremities.

thropoids diverge from a single ancestral line Such postural features therefore associated with an erect carriage of the body were consequently inherited in part by the anthropoids as well as by man The vertical body carriage of the gibbon, the most primitive of anthropoids, may well resemble in part, when on solid earth, the vertical posture and bipedal gait of the original representatives of the prehuman species

Prehuman Stages. Thus there are two distinct stages in prehuman development, leading to the erect posture *First* the preparatory stage which was set when the early quadrupeds grew into upright tree living types The *second* stage began when the prehuman stock came down onto the ground to undergo the final transitions producing mankind

Great Apes The anthropoid apes, on the other hand, largely remained in the trees acquiring their modern body skills which unfit them for efficient ground locomotion Their transition from quadrupedism to upright habits in tree life was nevertheless marked by gross anatomical transformations which established a primitively erect body now grossly characterized by the modern great apes. Changes superseding tree life, resulted in the refinement of posture and body stance leading to modern man.

Discussion. In brief it can be stated that the first group of changes are those produced on a previously quadrupedal animal through suspension by the arms while the second group of



Figure 6 b) Puppy vs. infant quadrupedal locomotion. Note excessive length of legs over arms in the man child, while the dog's extremities are about equal.

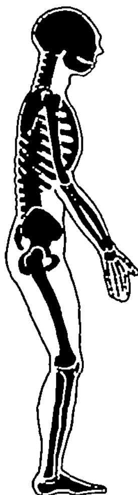


Figure 9 Neanderthal man, now extinct, showing his probable stance. Note lack of cervical lordosis.

changes are produced on a body supported by the two feet on the ground At the beginning of tree life the first changes on the body were due to the combination of the downward pull of gravity and swinging by the arms or brachiation characteristic of all anthropoids. Brachiation of course necessitated earlier changes in the forelimbs in order to evolve a grasping type of hand with which to cling to the trees Shoulder girdle muscles altered their positions and number The scapulae migrated posteriorly and the pectoralis minor insertion shifted from the humerus to the coracoid process Shoulder movements became complex and precise. Where quadrupeds needed a springy shock absorbing mechanism to land upon now brachiating habits needed strength in overhead grasping the opposite kind of functioning locomotor From the combination of brachiation and gravitational pull, there resulted a great freedom of circumduction motion in the shoulder girdle and a modification in the joints to allow full extension of the legs permitting an erect posture Man s hip joint mechanism is less well adapted than the shoulder It is a much later acquisition. The lumbosacral junction is even less adapted. It is still in a transitory state of evolution

## TREE LIVING ADAPTATIONS BY SUSPENSION

**Head and Body** The relation of the head to the body in the quadruped represents a hyperextension of the cervical region in the primitive axial spine. The position of the foramen magnum and the occipito-atlantoid joint is in general still posterior to the face

instead of occupying an inferior and more anterior position. When such quadrupeds evolved the upright posture, induced by suspension in the trees, the plane of vision was at right angles to the long axis of the body and the head dropped forward. Thus forward

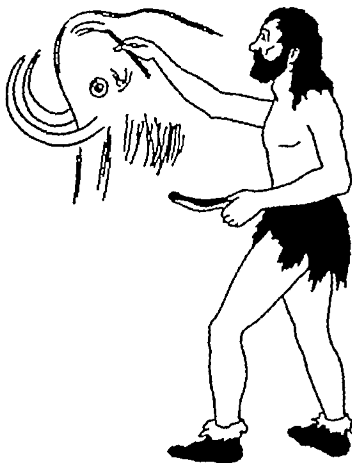


Figure 10 Cro-Magnon man, from whom stem most of present day mankind.

position was further increased by the necessity of lateral vision around the upward extended arms. The cervical spine then developed a forward curve and there was a change to a more inferiorly and anteriorly placed foramen magnum and occipito-atlantoid joint.

Brain. The brain developed upward and backward as the smell brain became a sight brain This increase in size was offset by a reduction in the snout so the cranium could be balanced more easily over the center of gravity of the body Greater mastication mechanisms were developing in the nature of powerful teeth and strong muscles These added requirements also produced a reduction in the size of the snout (face) Gradually the tilt of the foramen magnum, from opening posteriorly came to open anteriorly as is the case in man.

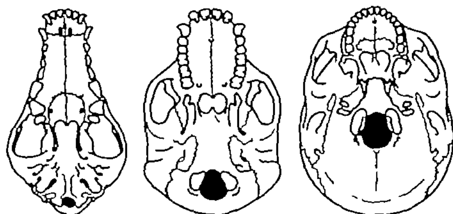
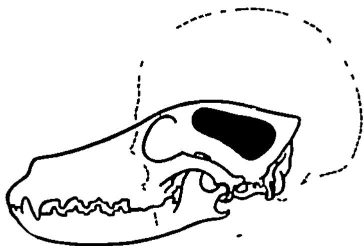
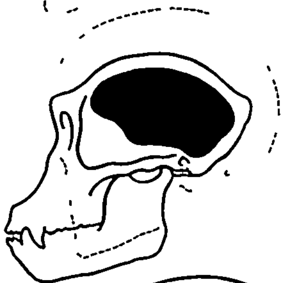
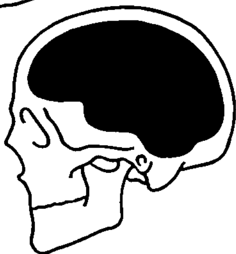


Figure 11 Base of crania, showing the position and size of the foramen magnum (in black) the dog, left, a smell brain in the chimpanzee, middle, a sight brain, and in man, right, the greatest developmental advance of all. This opening has migrated forward, as it became necessary to balance an enlarged, heavier head over the center of gravity of the body

Shoulder During the arboreal era, the locomotor function was removed to a great extent from the legs and was imposed upon the arms Suspension produced considerable traction on the shoulder girdle and the structures of the shoulder joint, the scapula and clavicle were profoundly modified. The greatest change was the development of power while the arms were in circumduction and in particular abduction. Most quadrupeds can duplicate our motion to a pretty good extent, anatomically but we can put our arms in all positions that any can and retain grasping power in them all. Thus the alteration of muscle masses and their added functions furthered the evolution of brachiation







Quadrupedal locomotion necessitated only the use of the fore-limbs in the plane of progression and there was very limited power of lateral motion In the quadruped, the shoulder blades occupy symmetrically lateral positions on the sides of the chest There is no clavicle in some animal forms, such as the dog because no functional demand for such a strut exists With the development of circumduction and use of the arms in suspension the scapulae came to lie farther back on the chest wall side by side while the clavicle was strengthened to give a firmer anchor for the powerful shoulder girdle muscles The function of the pectoral muscles was greatly increased and the serratus anterior no longer acted as a body sling muscle as in the quadruped, but became one of the chief factors in elevation of the arm above a right angle All of these changes were instrumental in producing a chest flattened anteroposteriorly rather than laterally which gives us freedom in head motion even while hanging from one or both arms.

Spine As by these brachiating habits the body could be slung by the arms from their base of support, the chest, further modifications followed the pull of gravity on a suspended object The spine which in the quadruped acts as a bridge between the fore and hind limbs and as a base for the suspension of the abdominal viscera, now becomes the direct means of suspension of the pelvis and legs and the abdominal viscera within the bowl like pelvis

Viscera. The upper viscera, the heart and lungs, instead of lying against the anterior abdominal wall and the thorax, as in the quadruped, become suspended from the upper dorsal and cervical spine by means of the fibrous pericardium. As a result of the vertical position of the body and the decrease in the anterior posterior chest diameters they lie in a more posterior position than in the quadrupeds.



Figure 12. Brain size of the dog, top chimpanzee, middle and man, bottom, as developmental changes took place Prognathism recedes from the dog to man, as the smell brain gives way to a sight brain. These postural changes are noted.

**Pelvis and Hips.** The pelvis, supporting the lower viscera within and the legs without, was held in a somewhat more horizontal position than in the quadrupeds supported in front by the abdominal musculature. The range of motion of the hips in the quadrupeds is through an arc of 30 to 150 degrees with an habitual range in locomotion from 70 to 85 degrees Suspension increased this to 180 degrees or more of extension with consequent lengthening of the psoas and quadriceps muscles The glutei were shortened and broadened with the gluteus maximus migrating backward and downward to become a powerful extensor of the thigh There was however no marked development of a lumbar lordosis. The extension of the hips was complete during this period. There was also considerable increase in the abductional and rotational power of the hips resulting from the necessity for agile and bizarre movements accompanying tree and ground life. *With extension of the hips is associated the correlated extension of the knees*

Other investigators consider such adaptations in a reverse order to wit, that leg extension, pelvic and related muscle changes all arose as requirements of terrestrial locomotion Such supportive agents as the foot, leg, hip and low back all responded to the grounded mass Nevertheless, bipedal locomotion became possible because man s basic structures were pre-eminently prepared to respond satisfactorily

**Foot.** The grasping function of the primate arboreal foot, to balance on the tree branch would act against a shortening of the calf muscles and an elevation of the heel, characteristic of the quadruped A fundamental change in the foot structure occurs with the increase in size of the arboreal primate The functional axis of the foot is transposed from that coinciding with the midline of the foot, to one between the first and second toes, and a grasping hand like structure was developed.

**Discussion.** The changes carried further resulted in the type of body posture presented today by the great apes. The prehuman stock shared these changes with the anthropoid ancestral stock. Continued arboreal life tended toward less satisfactory ground

living adaptations. The great apes of today as a result of prolonged tree life are poorly fitted for a ground living environment Man on the other hand has descended from primate stock which left the trees before many of these further changes had taken place The prehuman stock came from the trees before ground living efficiency was imperiled by too long arboreal life, but shared the basic adaptations. Thus the primitively erect posture was preserved and amplified, when bodily structures were most favorable to ground life

## GROUND LIVING ADAPTATIONS BY SUPPORTIVE MECHANISMS

**Prehuman Stock.** The second great group of changes, resulting from ground living habits is restricted to the human stock alone The effect of gravity on a vertically supported body by the fully extended legs is the inevitable adaptational force back of these changes The grasping character of the feet was modified by necessity Toes shortened and the climbing grasping foot was greatly modified to that of a weight bearing unit. The hands, to repeat were thus permitted freedom for other uses.

**Bipedal Stance.** As the principles of evolution all tell the same story so locomotion (chiefly by the arms) in tree-living quadrupeds was succeeded by true bipedal locomotion in ground life. The arms and hands were freed. No longer the clumsy forefeet of the quadruped, these structures became vastly more useful. Strong freely moving arms they were none the worse for their previous development during tree life. They retained their basic grasping power That is why man's hand is considered a "primitive" structure

**Probable Posture of Early Man.** The first earth bound prehuman types might well have been swift, adroit creatures of medium height with the sturdy body build of a young chimpanzee. At the same time their erect postural characteristics were probably more like the gibbon's Early man's arms did not keep up with the exaggerated development of either of these modern anthropoids but were of about the same length as the legs Therefore when

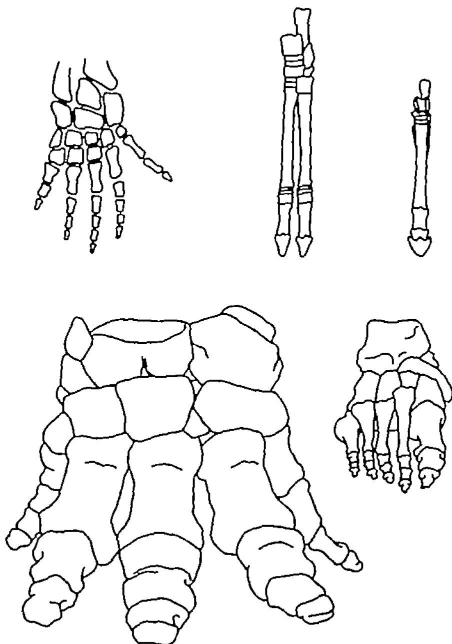


Figure 13 Foot bones show a basic pattern from the earliest **amphibian** form, **upper left**, the **horse**, **upper middle** and **right**, to the enormous land walkers, the **African elephant**, **lower left** and **man**, **lower right**.

these early men failed to maintain an upright stance they would be obliged to drop to a fully horizontal posture Their shorter arms made the semi-erect posture a near physical impossibility They were tailless and might have been covered with hair but probably had no ischial pad Their postural habits alternated between short standing rapid running and squatting Slow movements and steady standing were difficult. The head was thrust well forward and the spine although flexible, was usually held in a simple anteroposterior or rounded curve. The pelvis opened upward with a less flat lumbar spine The thighs were not kept fully extended upon the body but could be so extended The knees were slightly flexed but could also be fully extended on demand.

**Changes of the Foot.** In tree life the vital grasping function had called for the use of the anterior part of the feet, metatarsals and digits as the most important contact portion On the ground however the most important contact was moved backward between the heel and the metatarsal bones, especially as proficiency in standing and walking increased. When passive the feet assumed a supinated posture that is they rested on the outer borders and turned inwardly with the toes tending to assume a curled or partial grasping position This has been retained by the chimpanzee. In man, stress demands of weight bearing forced the inner border of the flexible arboreal type of foot to the ground flattening the entire structure The leverage axis continued to lie between the divergent first and the second toes as in the previous grasping position used in the trees Further mutations fixed this trait in man alone

**Other Bodily Changes** From this picture to modern man changes have occurred partly because of greater proficiency in ground living The development of the sight brain and the increase in the size of the vault in proportion to the rest of the skull, caused further modification in the shape of the face and the position of the occipito-atlantoid joint.

To aid man fortuitously in his quest for supremacy a slight cervical extension had appeared, to balance the heavy head over

the downwardly migrating gluteus maximus muscles and the broadening medius and minimus.

**Knee** Full extension of the knees is associated so closely with full extension of the hips that this motion was also attained during tree life The habitual full extension of the knees, however was not important until man s erect stance became an *habitual atti tude* The so-called locking of the knees in full extension has been developed as a part of the ability to maintain stance with a minimum of muscular effort.

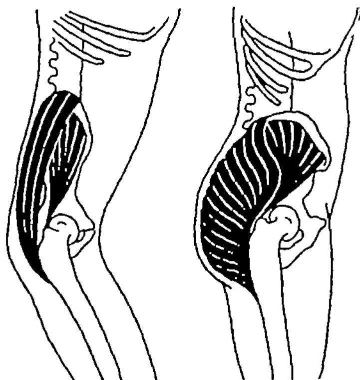


Figure 15 Black areas represent the gluteus maximus and medius muscle bundles in the chimpanzee, *left*, and in man, *right*. In the latter the medius remains in its original position, although it has shortened and broadened with the ilium, while the maximus has migrated downward and backward, so that its fibers are acting obliquely as powerful extensors and external rotators of the thigh at the hip. These anatomical changes seem to have taken place rather rapidly in man s evolutionary postural dynamics.

Efficiency of Erect Posture As has been described elsewhere certain attitudes of stance can be maintained with very little muscle action, except that used to support the head In this respect modern man presents a marked difference from his earliest ground living forms in which most of the extensor muscles were held in active contraction to maintain his erect position.

Foot The foot lost its grasping function and divergence of the great toe; the toes shortened and decreased in strength the greater rigidity of the foot with elongation of the heel followed loss of flexibility of the arboreal foot Man s foot has become a highly specialized organ of support for bipedal locomotion.

Other adaptations of the body to its present environment are so interrelated as regards its various parts that it is impossible to account for a change of any given part without correlating all parts of the body This is not possible within the limits proscribed by our presentation.

Summary In discussing so big a subject it has been necessary to ignore certain relevant topics and to telescope others. Reconstruction of primate and particularly the human phylogeny is a difficult task, although body dimensions and characteristics of living primates are well known. All primates demonstrate the unique tendency toward a high development of the central nervous system by cortical expansion within a relatively specialized body This is one of the most distinct features in man s evolution. Vision has played a major role in adaptation. Binocular perceptions have lifted up the heads of all primates and in particular that of man. His is a sight brain in contradistinction to the smell brain of lower animal forms.

Man has adapted his stance and locomotion to his environmental needs so well that the cerebellum now functions automatically with much depending upon pure postural reflex actions In the adult the upper extremities have been disengaged from these formerly necessary autonomic responses, whereas the lower extremities retain them The erect posture in man is achieved and maintained easily by these automatic neuro-motor reactions. Sherrington has described this substratum of man s muscular tension

correlations establishing reflex patterns of posture and progression.

Locomotion and posture are essentially physiological correlates. These particular adaptations set man apart from all other forms of animal life. His posture is unique. Man's ecological niche is set by his erect stance and his uniqueness This came first, but to be successful it demanded *rapid* changes stemming from primate arboreal preadaptations Man stood erect with a good brain, free hands coordinated to eyes but he was slow, open in the belly short of tooth and claws and no physical match for an angry "cat" It is what he did with this successful arboreal adaptation, when he became a terrestrial biped, that has counted most. Selection from then on was for intelligence, tool using and group behavior (which is best with language and traditions of successful ways) Man was a terrestrial success because of the developments of culture, subsequent to his permissive evolutionary origins. Without erect posture,—no tools culture or big brain but without the tools, etc.,—no man How this all was timed in evolution is moot, but one thing seems certain, and that was the speed, a *quantum evolution* in Simpson's terms

## PRIMATE ADAPTATIONS OF MAN IN OUTLINE FORM

1 Arboreal Environment

- a. Cursory-erect posture.
- b Eye hand coordination developing—
- c Shoulder chest, hip extension, free hands—all are basic anatomical structures involved in the process.

2. Terrestrial Environment—Early

- a. Fully erect, compensatory spinal curves developing—
- b Foot, ankle knee hip adjustments to gravity line of weight bearing
- c. Pelvic forward roll accomplished.
- d. Further freeing of hands plus using of tools (handy ones—not manufactured)

In this stage man was slow of foot unprotected except for his cunning and use of convenient tools to fight with He had many weak regions—open belly low back, hip joints

3 Terrestrial Environment—LATE

a. Big brain growing rapidly in ever increasing size.
b Greater coordination of eye, hand, foot and balance when running and climbing
c. Group success
Tool making—Language—Culture.

This latter makes man a securely adapted member of the world's environment, *come what may* His culture is transmitted and his curiosity constantly increasing. *He is nature's greatest achievement*

CHAPTER II

# ENVIRONMENTAL INFLUENCES

ENVIRONMENTAL circumstances are among the chief influences in producing man's postural dispositions. With his hands freed from locomotion he produced tools and established the earliest stone age cultures. His sitting and squatting habits, his versatile hands and his capacity to run rapidly for short distances aided him in his survival Many other adjustments during the past one million years have conspired in man's favor while others have mitigated against his adaptation Finally man has taken matters in his own hands and actually adjusted his environment to himself by inventing clothing fire for cooking and weapons for defense. In many ways, too numerous to mention man has adjusted his environment and with it all has conquered the world Some people fear that he has proceeded too far and self destruction is probable. This can never be the case because posture also indicates attitudes, behaviors and responses all of which develop man's sight brain with, we firmly believe, man's self redemption inevitable because of his accompanying intellectual development.

Structural adaptability of man to his environment is never greater than the extraordinary capacities of his body Wolff's Law states that the internal structure and the external shape of a bone conforms to changes of applied stresses. He referred specifically to adult bone. Other tissues such as muscles fascia, tendons and weight bearing fat pads have similar characteristics Ligaments show these tendencies least of all. To this adaptability of body tissues is due in great part the structural varieties of normal seen in healthy individuals

Extreme conditions of environment usually not beneficial in nature also produce changes in structure as portrayed in man's posture These will be discussed later Beneficent or natural conditions are of two types those related strictly to the internal or

physical environment such as growth and development and those pertaining to special activities of man such as training for sports achievements or military accomplishments.

## GROWTH AND DEVELOPMENT

**Intra-uterine and Babyhood** The forces effecting intra uterine life appear to be relatively simple though they are not profoundly understood. Growth takes place against the resistance of the elastic uterine wall. The foetus is almost invariably in a position of flexion. The convex curve of the spine lies in contact with the curve of the uterus As growth progresses, there is a constantly increasing pressure equal in all directions but always in a position of flexion The head is sharply flexed on the body the arms and legs flexed on the torso The back assumes a long convex curve corresponding to the curve of the surface of the uterus. The body tends to assume as nearly an elliptical shape as possible The softness of the cartilaginous skeleton is such that modifications and variations of position in utero are usually not important. However there are numerous congenital anomalies which are thought to be attributable to various distortions of position, such as clubfoot, congenital dislocation of the hip wryneck etc. The probabilities are that these conditions result from distorted positions in some instances but other causes must also be operating in their production. The entire foetus lives in a fluid medium.

At birth a very definite change takes place in the environment. Previously the child has been surrounded by the uterus and partially suspended in the amniotic fluid, the specific gravity of which has varied only slightly from that of the child itself The gravitational effect is very similar to that exerted upon an individual submerged in sea water However after birth, gravity exerts a pull in a median of far less specific gravity the air and the mass of the child and its parts become more important as related to posture. This is discussed in Chapter I.

During the first year it may be said that the child is in a near horizontal position, either prone or supine Gravitational pull is therefore exerted on a horizontal plane and tends to unroll the

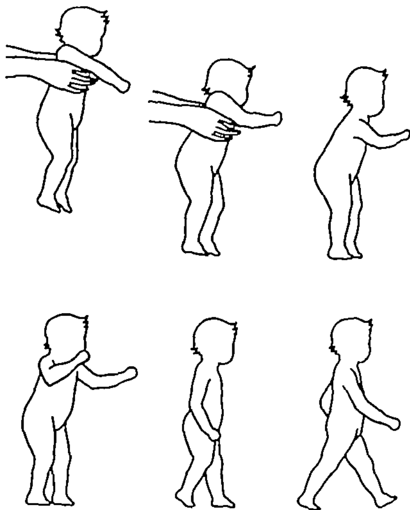


Figure 16 Early Phases of Infant Stance indicating serially the positions of infants bodily parts while learning to sit, stand and walk.
a) Usual method, by adult assistance, placing directly on feet.

"coiling" which had been previously assumed within the uterus. In the prone position, the flatness of the crib surface causes the child to conform to a straighter position, while in the supine position the head and legs tend to lie flat but are allowed greater freedom of movement.

There is a great difference in the rate with which muscle power is developed in the different parts of the body. The abdominal

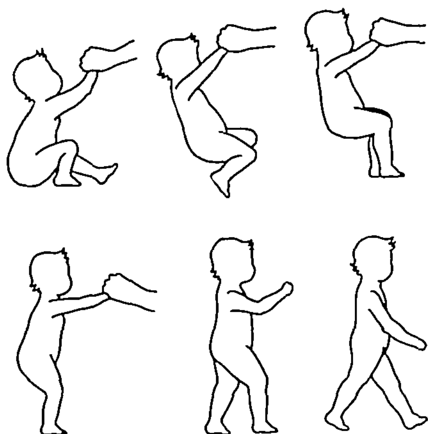


Figure 16—b) Partial assistance

muscles are stretched to their full length but of little use at first. The stretching of the anterior muscles of the neck, resulting from the flat position of the child parallels the stretching of the hip flexors. Thus the muscles which are relaxed, the extensors of the neck, back and thigh are the first to manifest their power The abductors of the arms, and the extensors of the elbows, wrists, fingers knees and toes, as well as the plantar flexors of the feet, are thrown into functional activity by the reflex stimulation of joint mobility and the gravitational effects are less

The earliest clutching attitudes of the hands and feet are representative of the flexor reflexes so strikingly developed in the other primates particularly the chimpanzee and the gorilla. These disregard their infants as far as transporting them during

their early months of life so that the infant immediately after birth clings to the abdominal hairs of the mother when she moves about They have been observed climbing forty to fifty feet off the ground in trees with their young precariously clinging to their belly hairs After awhile, the young cling to the mothers back and "ride" as she gets about This reflex has been called

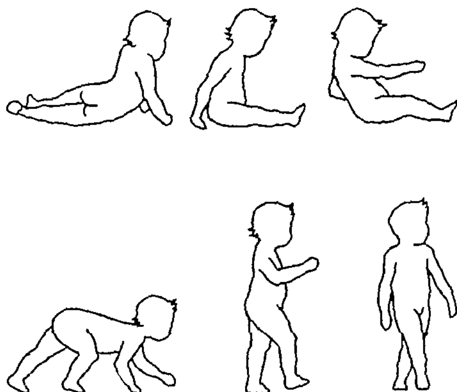


Figure 16—c) Child totally on its own.

the "Moro reflex" and is lost in human children after a few months, unless the child is mentally deficient when it is observed to persist for six to twelve months following birth

Other interesting reflex postures of the young infant are reaching for the flat surface of the table when raised and lowered face downward This is a conditioned upright reflex predisposing to an erect posture If the young infant is grasped by the torso and held face downward over the table it will reach for the surface as

it is lowered slowly using both upper and lower extremities Foot grasping reflexes, great in some infants accompanied by the power of maintenance of its own weight by the grasping strength of the fingers are commonly observed during the first few months In the chimpanzee this capacity is remarkably prolonged in time leading to brachiating acrobatics of an astonishing degree During this age of growth and development the human child is rapidly surpassed in muscular achievements by the lower primates Needs



Figure 16—d) American Indian child on cradle board, learning to assume the erect posture. Actually child is standing on the bottom of container on mother's back during most of the time. This undoubtedly stimulates the body-righting mechanism through foot contact.

of survival have produced these varied rates In man, the infant is protected and in the chimpanzee it is apparently expected to shift for itself

The comparative slowness of the development of power in the back, neck and hip extensors is obviously due to a relative muscular weakness compared to the weight of the parts to be moved. When the child is able to support his head by the increased power of the cervical muscles he begins to sit up The weight of the head, together with the still persistent flexion of the hips produces a long convex curve throughout the entire length of the spine. The degree of this curve depends to a great extent on the amount of time the child has spent lying down. In the case of children who have spent a longer time in the lying position for any reason, there is an overdevelopment of the erector spinae muscles and the back is straight in the sitting position. But normally there is some persistent hip flexion during this stage which is associated with the upward rotation of the pelvis on the spine resulting in a convex lumbar curve while sitting up *This curve is the normal* back curve for the sitting child in the prewalking stage. When the child is about to stand, the musculature of the extensors of the back *and neck has become well developed and the back is* usually straight, the straightness resulting mainly from the slight tilting upwards of the front of the pelvis in full or nearly full extension of the legs *The child who has shown a straight back on sitting,* will soon show a slight degree of lumbar lordosis on standing This lordosis can be explained in part by the comparatively rapid development of the erector spinae muscles.

About the time the infant learns to walk the abdomen protrudes prominently because of the new vertical application of gravity and the relative weakness of the abdominal musculature. In proportion to the prominence of the abdomen a lumbar lordosis develops The normal posture of infants therefore shows a prominent abdomen and a slight lumbar lordosis with usually a relatively straight to convex upper back. The persistent tendency in the erect standing position toward full hip extension as a means of easier and more perfect balance is natural and necessary

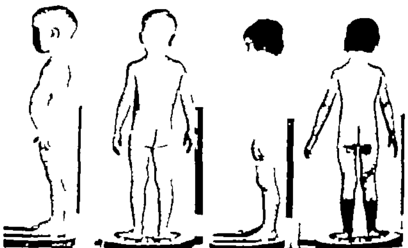
At this precise moment the *human child, because of his great*

heritage is able to rotate his pelvis forward and upward by means of his gluteus maximus as has been indicated in Chapter I Thus he differs from and increasingly forges ahead of the other primates, relative to the erect posture *and locomotion* His prominent abdomen, if a late walker may be aggravated by disorders of malnutrition such as rickets, scurvy and a heavy diet of liquid *foods* *Children should not* be constantly filled with milk and gruels. Feeding solid foods is of necessity to be rapidly encouraged as soon as the child has embarked upon the exciting experience of walking

The feet of a child are among its greatest distinctions relatively speaking, and need special attention During the first two years of life hormonal effects, derived from maternal sources during intra-uterine existence are operative, producing relaxation to a varying degree, of the ligaments tendons and joints In this respect there are frequently observed a variety of foot pronations and slack calf structures accompanied by otherwise normally acceptable postures of the rest of the body These need watching yet rarely require corrective procedures at this time They usually "tighten up" and become functionally suitable Too often parents, *and particularly grandparents, stampede the use of supports and* shoe alterations, most of which do no harm and may serve as a return ticket, so the physician may watch the child grow As a public health measure, in this regard, one-eighth inch wedges of the inner margins of heels are not harmful where greater wedging may destroy the shoe counter A pronated foot has a long heel cord—this is axiomatic. Raise the entire heel one-half inch and the rest responds accordingly Some children may be of the fat body type by heredity and will have many of their joints relaxed, "double jointed." Little should be done of a corrective character in such instances because it is futile

Pre-school Age The baby of the American Indian very early in life was *strapped to a cradle board.* Although being removed frequently he nevertheless spent much of his time in the extended position. The actual effect of this custom as regards adult pos






ture, can be surmised possibly predisposing to subluxated hips "Straight as an Indian" is a phrase which was frequently used during the last century But so many other factors enter into the "straightness" of the Indian such as the hardness of his bed the extremely active character of his childhood his reliance on strength and his natural heritage, that the importance of his earliest environment on the cradle board can only be approximated

On the other hand, many babies are kept from birth in the softest of feathers and silk and are never allowed to lie on anything which might be hard. These children would seem to present a babyhood environment as far removed from the papoose as can be imagined, yet there is no proof that they do not grow as straight as the Indian, considering this factor alone. Another angle of consideration that the chance for exercise, movements of the muscles and their consequent development, is much greater in the unrestrained baby There is no doubt that "straightness" can be arrived at either by support or muscular activity and there are advantages and disadvantages of both. The reverse, that "crookedness" can result from either incorrect support or incorrect exercise also is true and this must be considered here with special regard to incorrect clothing, exercise toys and furniture

The clothing of children at present is in general quite good from a postural standpoint. It is loose and light and does not impede free motion The diaper may be a factor in bowlegs in children with rickets but it is probably not an operating cause in normal children. The use of diapers is practically universal whereas the proportion of bowlegs is relatively small and can usually be traced to rickets in most severe cases Shoulder sup-



Figure 17 Average Posture, ages one to two and three years Ranges from early relaxed bodies to good muscle and ligamentous tensions at age three years. Wide stance and simulated bowed legs, tightening up by age two so that knees may seem to be too close together becoming nicely straight at about three. Pot belly (relaxed abdomen) and a moderate lumbosacral lordosis noted. Put a glass on illustrations and observe the degree of pronation usually present at these ages.

porters for clothing are said to produce round shoulders but the weight attached to them in children is slight. It is probable that here again the cause is more profound. Shoes and stockings are much more important. The prevalence of deformed feet is well known. This deformity is the result of very early factors in many cases On the other hand, much has been written concerning improper shoeing It should be repeated and emphasized that the shoes are not alone responsible. In children the stockings are frequently at fault. The tight stocking is very common both because of the shrinking which occurs during washing and the rapidity of growth of the foot in smaller children. The tight stocking produces a long continued gradual pressure against both ends of the foot. This pressure does not have to be great enough to cause any discomfort to the child. But even a slight pressure, continued for twelve to fourteen hours every day can eventually produce deformities In accordance with Wolff's Law the external conformation and internal structure of the bones of the foot change to meet this pressure. The tight shoe is a more obvious but perhaps no greater factor The combination however is disastrous A very frequent combination is the tight stocking with the extremely pliable moccasin If a foot is normally strong and has not been previously injured by tight stockings a moccasin is probably innocuous but its pliability in the deformed or weakened foot only allows increased deformity to take place A shoe with a firm flat sole and soft counter if large enough, will help the foot to develop in its normal pattern Infants can be barefooted without harm during the first eighteen months of life.

Abdominal supports and shoulder braces are forms of apparatus usually not worn until some evidence of deformity has appeared. The advisability of their use depends on the individual case. But, as preventive measures they should not be used. The artificial supporting of the abdomen or shoulders will only result in a weakening of structures involved so that a greater dependence on artificial support will follow This can create a vicious circle

An interest in the play of the small child has of late years produced a multitude of toys, some of which have a very definite effect on the posture of the child. Of especial importance are

the so-called walkers The purpose of these walkers is twofold to assist the child mechanically in learning to walk and to relieve the mother of the frequent task of lifting the child from place to place There are many types and some have decidedly bad features In many the child is unable to place the whole foot on the ground and accordingly walks on his toes There is no weight bearing as the weight of the child is taken on the seat of the walker The thrust is on the toes with flexed knees and hips to allow clearance There is usually a handle bar on which to rest the arms. In some types the seat is hung on a spring The result of the long continued use of such apparatus may produce too great a shortening of the heel cords and its resultant effects higher up, such as back knees hip flexor contraction and a deep lumbar lordosis. A case was seen recently in which the gait of the child when walking alone was exactly that produced by the walker This child was otherwise perfectly well In this case of course, the use of the walker had been continued too long and after several months during which it was not used, the gait gradually became more normal except for the persistence of short heel cords. The walker if used at all should only be a plaything for the child and not a constant means of locomotion.

Occasionally a lateral foot deviation has resulted from the use of toys propelled with one foot, but this is very unusual and hardly of importance in the normal child. The use of any given toy is seldom persisted in long enough by the normal child to have any deleterious effect. It is only when the child is limited to one type of play or is placed in a walker for hours at a time that any lasting postural defects will result.

Summary Environmental factors related to posture in the well, pre-school child are therefore confined chiefly to the feet and abdomen Deformities of the feet and the early age of their onset are partially environmental These structures may show pronation, short or long heel cords, hallux valgus, contracted toes and many other lesser abnormalities. It goes without saying that the average well formed and responding child should not need shoes during the playtime on grass and sand Sleeping of course, calls

for removal of all foot gear Positions should be changed frequently Nails are clipped straight across and feet washed daily The child may pick up a fungus infection, common to most all foot environments just as in the adult. This requires treatment.

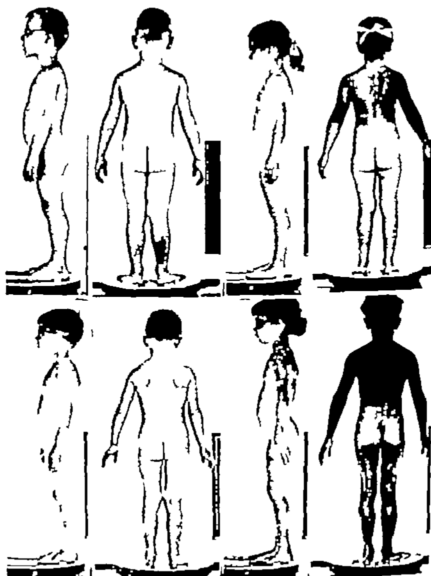


Figure 18 Averag Posture, ages four to five years. Relaxed extremities may per allowing a back knee slight in extent and a rounded to mil belly Lordosis is diminishing at these ages.

**Middle Childhood Period.** Between four and seven years of age the child's individual body type begins to unfold The boy and girl are very much alike in their postural attitudes and components Texturally the girl child is of finer quality but body proportions and correlated architectures are almost indistinguishable. About age eight years, the girl usually surpasses the boy in stature and frequently in weight. Growth rates are unequal thereafter until the onset of menarche when the girl has introduced into her blood stream the androgens, whereby stature is tempered and eventually stopped. The boy continues usually showing greater stature because of greater growing time for one thing, and because his steroid stimulators are geared to masculinize him (muscularize) with proportional corrolaries that are obvious.

The normal child at the age of four shows a comparatively constant average posture The feet often show a slight degree of pronation with the toes somewhat crowded together The heel cord is sufficiently long to allow dorsiflexion well beyond a right angle Knees are straight when standing, but there is a tendency to incomplete extension in walking as well as running Hips show slightly less full extension when standing than in the adult The pelvis is tilted forward the abdomen prominent and the lumbar lordosis fairly well marked. The chest appears flat, the ribs are down as a result of the direction of pull of the abdomen The dorsal spine is nearly straight and the neck shows a mild lordotic curve with no forward inclination The flatness of the chest may give an appearance of round shoulders, but the shoulder line is usually sufficiently well back. Variations from this posture, which are not caused by disease are, for the most part exaggerations of pronation, accompanied by a slight degree of knock knees or bowed legs and an exaggeration of the abdominal prominence with its attendant lordosis The increased size of the abdomen results frequently in a long lordosis extending to the upper dorsal region and producing prominent scapulae. This and the less developed chest are correlated with round shoulders Body types are important. They may be classified as fat, muscular and linear with each showing accordingly their relative preponderance of each component. Many variations of normal posture at this age

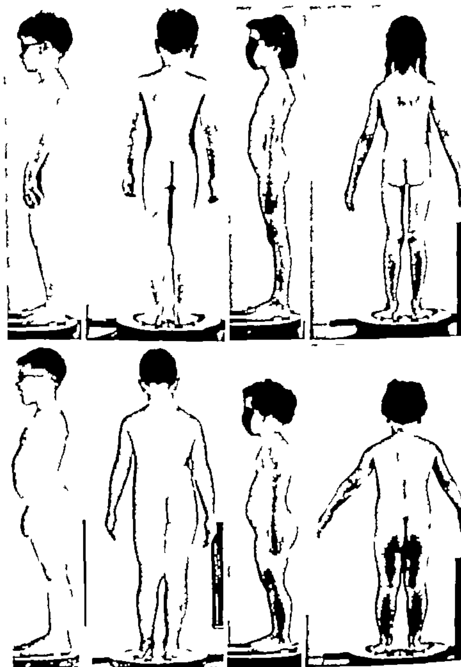


Figure 19 Average Posture, ages six to seven years. Body types are beginning to be parent, the fat type shows a more protruding abdomen and an accompanying lumbosacral lordosis.

are dependent upon these components which are genetically conditioned The parents should be observed for their body builds Except in rare instances the child will "take after" one or the other parent because body types seem to be dominant traits In this regard the fat little girl, with her tendency to knock knees and a pot belly must be distinguished from the overweight, muscular child The former cannot be reduced in weight while the latter will "slim down" without too much difficulty The thin lad may often be slightly stooped. This, too, is occasionally an inherited body trait and no amount of corrective devices exercises or admonitions will change his postural stance. This boy will carry additional body traits which will need more attention than his apparent poor posture Body types will be discussed later

As a result of the increasing mental awareness of life and accompanied by the driving forces of growth, there is a metamorphosis from the little one which must be guarded to a self reliant eager happy and consequently extremely active child. All curbing of this activity is irksome. The child is constantly running jumping, falling, although seldom hurt, and his life consists normally of near perpetual motion This activity is a necessary part of his development. The bones are still plastic, and motion and use are essential to their continued development. The disuse atrophy of the bones seen on x ray after wearing a cast even for a short time is evidence enough of the necessity for activity and in normal children the development and hardness of the bones bears a direct relation to activity As a corollary to this the relative perfection of posture therefore depends to a great extent upon activity The posture of the normal child is usually a direct indication of his activity

But good posture at this age is not the same thing as good posture in the adult. There are many reasons why it should differ Chief among these is the plasticity of the child

The normal child of this age is usually quite flexible, judging by adult standards The muscles themselves are more pliable the ligamentous strains in children are rare and are only seen as the result of injuries The epiphyses of the bones have not united with the diaphyses and there is throughout the entire body

Figure 20  A erage P sture ages eight to nine years. Relaxed abdomen still common b t l g ment of extremities and center of gravity now approaching good l l r  Boys and girls look alike and grow almost at the same rate unt l tl l r age of nine when the girl begins to go ahead of the w Female texture is always finer

structures an elasticity which few adults possess This does not mean that the individual joints can necessarily go beyond their full range of motion Real "double jointedness" is a congenital variation not seen in the normal child The plasticity of the child can be used to develop an apparent double jointedness by persisting daily in the extreme motions until adult life. The contortionist is not necessarily double jointed The particular motions which he can perform have been practiced since early childhood But other motions, not practiced are of no more magnitude than in other normal children There are, however a few contortionists who are really "double jointed." This term simply means that the capsule of the joints and the ligamentous structures around the joints are extremely lax, thus allowing almost unlimited and bizarre movements The condition, as has been said, is usually inherited.

The stiff inflexible child is occasionally seen, but he is not the normal type and in practically every case definite causative factors can be found. These factors may indicate some earlier limitation of activity There may have been an acute illness necessitating a prolonged stay in bed followed by a lack of desire for activity from weakness fatigue or malnutrition.

Summary What then is good posture in the normal child of the midchildhood period? The answer can only be stated in terms of a given position as relative with many variations all of which are acceptable. However it is possible to determine the degree of efficiency of the use of the body as a whole and of the muscles of stance in particular

The neck, shoulders chest and upper back must be considered as a group The neck and upper back should be nearly vertical, and if they are, the position of the chest and shoulders will be satisfactory

The positions of the lower back and abdomen are usually quite different from that of the adult. There is frequently a rather marked lordosis with a moderately prominent abdomen. This is a carry over from the pre-school period. A flat abdomen is very rare among children and is usually the last postural trait to

achieve. In fact, the flat abdomen is a characteristic of good posture usually found in the young adult period. It again becomes a rarity after age thirty five.

**Pre-adolescent Period** The general carriage is good that is, the weight of the torso is not carried backward, and the line of gravity from the mastoid falls slightly ahead of the ankle joints, usually over the head of the astragalus Between age eight and twelve in females and up to fourteen years in males muscles are growing in strength. Coordination is acquired in preparation for the skilled types of play to be learned during the adolescent period. The efficient action of flexors and extensors must be increased and perfected during this period before skilled muscular activity becomes possible.

It must be emphasized at this point that, in the pre-adolescent child a prominent abdomen, associated with a lumbar lordosis and a slightly flattened chest, is not a postural defect, and that children showing otherwise good posture should not be included in a corrective class for this condition. A persistently prominent abdomen and its associated lordosis may be a normal variation at this age It may result partly from diet filling the stomach and intestines with milk or Coca-cola must of necessity result in an abdominal prominence An attempt to compress the abdomen anteriorly by the muscles of posture under the circumstances, would be futile and bulging would take place laterally as in compressing a rubber ball. This leads to weak abdominal muscles. As the child becomes older and eats more concentrated food his general activity increases by strengthening of the abdominal musculature with the combination of these two factors resulting in a flatter abdomen. Muscular strength is increased and posture is improved Kraus (1954) presents a discouraging note when he reports a large percentage of American children are muscularly deficient in this regard

Corrective exercises in pre-adolescent children are useful for actual defects but the percentage of defects in the author's experience is [illegible] all so that corrective classes are found to be made up in the [illegible] of children who are ill or recovering from an ill-



Figure 21 Average Posture, ages ten to eleven years. Boys are slimming down, girls are rounding up by early secondary fat deposits, a sex trait. Breast buds make their appearance. Girls gain in stature more rapidly

ness. This is in great contrast to adult corrective classes in which the majority of cases are healthy individuals with defects due to adolescent or adult environmental factors The older child who is put to work in industry agriculture or heavy housework may often develop a rounded back. Occasionally poor nutritional factors may accompany this stance. In these instances environmental influences are insidious and catastrophic. The child, who is decelerated in growth for one reason or another during this span of

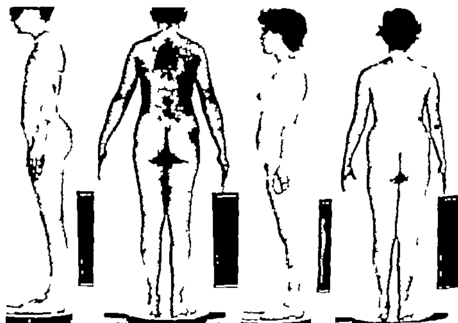


Figure 22. Average Posture, ages twelve to thirteen years. Secondary sex changes in the girl are greatly accelerated with the average onset of menarche at age 12.7 Note how boys are not yet showing signs of masculinizing. Their posture body types and fat deposits are about the same as at ages ten to eleven years

development may suffer a true osteochondrosis of any one or more of the pressure centers of growth such as the capital femoral epiphysis (Legg-Calvé-Perthes Syndrome) the tarsal navicular (Kohler's disorder) or the upper tibial epiphysis (Blounts disease) These may all predispose to poor posture and to even catastrophic sequelae

Summary The pre-adolescent posture is generally a relaxed posture with the defects of the earlier ages diminished in degree Greater muscularity in boys is about to take place and girls are apt to be taller and overweight. They are beginning to show sex variations. Textural components are notably different Body types are pronounced with an over all differentiation emerging to the trained observer leading to the great "shift" in practically all categories, that is about to take place.

Adolescent Period. Popular notions associate this time of growth with awkwardness a fallacy flatly contradicted by experimental literature Following onset of the menarche in the female or spermatogenesis in the male, bodily changes are profound. Motor coordination increases steadily throughout this radical period of development Apparent awkwardness is due to lack of social experience, savoir faire In this respect, posture often is notably poor

Individuals who mature early are usually of shorter stature more muscular while late maturers often are taller and fatter They have a longer time to grow in because adolescence is a time of altered internal environment due to the estrogens and androgens that are pouring into their bloodstreams These latter hormones begin to slow statural growth eventually stopping it altogether by the time females are seventeen to nineteen years of age and males are nineteen to twenty-one. Slow maturing boys, often fat boys, should not be confused with those who manifest true Fröhlich syndromes In this syndrome there exists an accompanying diabetes insipidus lacking in the late maturing males

During the ages of eleven to seventeen years for girls and thirteen to nineteen years for boys skilled forms of exercise should be substituted for definite play activities Games which among younger children required activity of the body as a whole, such as hide and seek, digging in the sand, running etc., are substituted for by games in which individual superiority is developed This superiority may be of mind or physical coordination or physical strength There is evident at this age a marked difference between the play of children and the play of animals which was formerly

Figure 23. Average Posture ages fourteen to fifteen years. Boys are still lacking in secondary sex changes, while girls are now nearing their full maturation stage.

Figure 23—Continued.

less noticeable Boys and girls now play baseball, football, and basketball, or if their particular aptitude lies in the finger types of coordination, they draw paint, or play a musical instrument. Others show increased mental facility and the "student" type begins to emerge. Special interests begin to show themselves.

During this period of growth, body types become fixed, and the "genotype" manifests its morphotypical appearance. Such body types are genetically conditioned and only in a very limited sense may they be discussed in a chapter on "environmental influences" These will be fully discussed in the next chapter It is sufficient now to enumerate the types as fat, muscular and linear and to point out that these inherited body types are structurally different with temperamental overtones accompanying each polar division.

Another element of importance in the posture of the adolescent, which should be *strictly classified as a metabolic factor* is the rapidity of growth As has been stated, some children grow with extreme rapidity during this age while others grow much more slowly Those who grow rapidly tire easily and may assume faulty posture positions because of fatigue Over-exertion must be prevented by rest periods The Danish recruit, the farmer boy and the Welsh coal miner lad are apt to develop a dorsal stoop if made to exceed their physical capacities. The adolescent athlete must be protected until his centers of growth are nearly or completely closed, or due consequences of trauma during contact games may follow Posture, as observed in this age has a wide range of so called normal and accordingly such individuals must not be judged too harshly if they slump readily or are inclined to lag behind

Throughout this period there is a gradual adaptation of the body to its ultimate size muscular strength and coordination The individual must become accustomed to an internal and external adult environment Physical and mental adaptations mirror each other Mental attitudes are both responsible for and the result of physical conditions of the body and its environment. Conversely the environment produces definite effects in mental processes. We all know that the individual's posture reflects mental and physical

attitudes The depressed, slumped posture is contrasted with the erect head well balanced, springy gait of the happy well motivated individual Psychobiologists have long studied posture as symbols of thought In the pre-human anthropoids posturing is usually the only language used to express their attitudes Fear causes cringing or flight while a contented free from fear confident chimpanzee will clap its hands jump up and down or even make a kissing gesture with its lips.

A classification, therefore, of the adolescent must be arbitrary No classification during such a formative period can include all aspects. Mentally bright and physically efficient types often overlap and yet in many instances they are far apart. Physically active and physically inactive individuals may run counter to their activity in their physical development.

The defects most commonly seen are those of a relaxed attitude pronated feet prominent lower abdomen a dorsal kyphosis and an unequal muscular development—uppers behind lowers The forward position of the shoulders is an occasional accompaniment of the rounded back position Postural defects of adults in general usually have their origin in the physical or mental disorders of the adolescent period. It is then that postural correction should be emphasized. It is during adolescence that the principles of good adult posture should be taught. It should be required of high schools and preparatory schools to develop good posture. It is not only most important at that age, but it is most satisfactorily carried out.

Young Adult Period The end of the adolescent period is approximately the end of the period of physical growth Army studies have definitely proven that healthy adult males continue to increase in stature and in some extremity and thoracic dimensions to as late an age as 25 years There is no longer necessary a constantly shifting adaptiveness Clothes and shoes are not outgrown Physical skill and strength have been developed to a high degree Habits of thought and activity have been formed. During adolescence, the youngster seems to know no limitations for day by day and week by week, he finds himself stronger and larger

The results of this are the recklessness and assertiveness frequently *seen in the older adolescents. But with the cessation of growth* the individual comes to realize his limitations relative to physical and mental achievements The athletic boy or girl is usually aware of his or her potentials and may be directed skillfully toward very

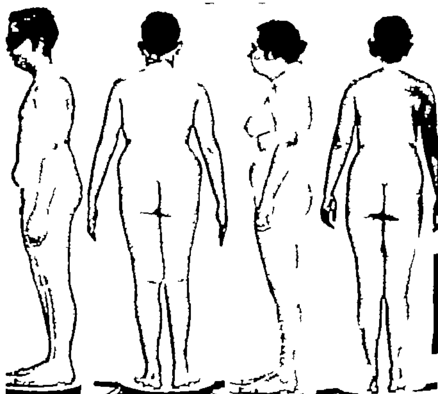


Figure 24. Average Posture ages seventeen to nineteen years. Graceful, co-ordinated individuals the age of poise and greatest sexual potentials. Body types now firmly established posture excellent.

high accomplishments near the end of adolescence He is tall or short, strong or weak, heavy or light, and as such takes his place, compared with his fellows These are dependent, as has been said, on his interests and abilities his likes and dislikes in food, people, type of work, and types of play *Interests and abilities are closely* inter related. There are the individuals skilled in small coordi nated movements Their interests will develop accordingly and

Figure 24 See legend on facing page.

musicians engravers watchmakers surgeons and miniature painters may be their goals Those skilled in the large coordinated movements will be the athletes artisans mural decorators, flyers and business executives If the abilities are essentially intellectual rather than physical, student goal is more likely The highly coordinated individual, usually has the better mind. The obvious corollary that the awkward, uncoordinated individuals usually remain awkward physically and mentally needs no comment.

Summary In the newborn the Moro reflex—grasping or clutching of the hands when startled—is apparent. This is common in all primates It should disappear in two to six months unless mental retardation exists The labyrinthian reflex—head of infant struggles to remain in balance when body is lifted—is first observed. A Babinski reflex is present for first twelve months of life often accompanied by an ankle clonus. A tonic neck reflex is early observed. Still another interesting reflex action shows the arms following the head, when it is turned to one side while the leg on the opposite side is drawn over A Chvostek sign is frequently present at birth. An abdominal reflex appears at about the sixth month and the falling reflex—arms and legs stretching for the table top when the infant, face down is lowered toward its surface—begins to appear at the second month

The child usually sits up at six months but falls forward on its face flexing at the hips Standing is possible at twelve months, running at twenty four months and climbing stairs right foot over left foot, at three years of age Hand dominance becomes apparent about that time

An infant learns to sit first and then stand, with postural patterns characterized by incoordination widely spaced feet, moderately flexed hips and knees balancing precariously with the aid of his upper extremities There is a need for strengthening the back and abdominal muscles as quickly as possible. The amount of liquid food should be restricted to reduce the usually observed protruding abdomen

The pre-school child may show normal varieties of bowlegs, knock knees intoeing outtoeing, heel pronation and a pot belly These are correctible by training plus the usual growth increment

which balances off these disorders to a surprising extent Fatigue illness and specific maladies may require special management through postural training

School-age children offer the greatest challenge to those who are directing their growth and development. Osteochondroses are common as causes of postural disorders together with cultural attitudes fatigue and acute infectious diseases. These are met by specific measures.

Pre-adolescent and adolescent youths may have serious disorders affecting their posture Fatigue is a common complaint These require careful attention

Environmental factors both internal and external in character conditioned by the individual's inherited body matrix with its many growth patterns, are operating to produce good or bad posture Definitions are illusive concerning posture The concepts proposed may be considered beginnings toward a better appreciation of the multiple factors encountered when defining a fluid, dynamic, holistic state of being such as posture

Young adults are at their physical peak and need skillful directing in their activities to avoid serious injuries in contact games. Good coaching is of primary importance

CHAPTER III

# NORMAL ADULT POSTURE

**Descriptions.** Gregory (1928) quoting Milton's *Paradise Lost* considered man's upright posture as "of far nobler shape, erect and tall, godlike erect." In the next sentence he disillusions the reader by attributing man's colossal and impregnable superiority complex to the erect posture. Morton (1952) mundane and practical, describes the normal standing posture as the position in which the body center is located perpendicularly above the center of the ground contact area of the two feet, so that its margin of stability is practically equal in all directions There exists a fluidity of equilibrium with the center of gravity somewhere between the two navicular bodies and all other structures piled above them, bone on bone maintained in balance by a muscular tension within the powerful gastrocnemius and a very slight reciprocal tension (motor action) of the anterior tibialis This was demonstrated by Goff (1951) (1952) and recently by Basmajian and Bentzon (1954) using electromyographic methods. Occasionally the biceps femoris and the semitendinosis muscles demonstrated tension when the feet and knees were placed together but if they were fourteen inches apart almost no tension was observed in the thigh muscles The leg muscles were always in an alternating state of tension in either position This was not a "strain" state but quite the contrary In the adult male the gastrocnemius was more active while in barefooted females both leg and foot muscles were alternately active in standing positions. If high heels were worn the activity of the gastrocnemius and peroneus longus markedly increased. The center of gravity was farther forward.

**Locomotion.** This near relaxation of man's erect stance contains the secret of his stamina He is actually in delicate balance, poised for locomotion in any direction Morton likens this poise to the top grade of a roller coaster and the forward step phase as coast

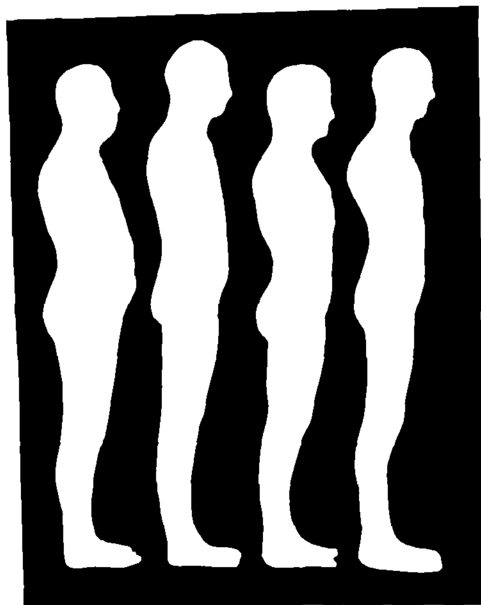


Figure 25 Mean Posture Patterns From author's (G) orthograms of posture army series. Left to right. Fat body type- balanced, muscular and thin, elongated. Their percentage of occurrence in the army population was 10 99 26 02, 10.87 and 18 0 respectively These are valid mean postures of white males in good, general health (Reproduced by permission from *J Bone and Joint Surg* )

ing down the incline and almost up the next slope by the body's momentum But little energy is needed to finish the push to the top and thus the next step of locomotion is initiated. The process goes on for each step with a great saving in energy for the individual.

Steindler (1935) and Saunders Inman and Eberhart (1953) have exhaustively analyzed locomotion in the bipedal posture of man and describe the center of gravity as moving through a sinusoidal pathway of low amplitude in which the deflections are gradual. They likewise consider this type of gait as conserving of body energy Man's bipedal posture can be maintained only if energy is saved. In the long run this conservation spelled survival over the remote million years during which man struggled to conquer his environment. This adaptation process has been described as a "natural experimental method" of learning. Some investigators held that a child does not accomplish coordinated locomotor habits for running until at least three years of age while others believe it takes seven years of learning for stability achievement. A chimpanzee cannot run when assuming the erect bipedal stance

**Definitions of Posture** It is at once apparent that normal human posture is a very complex pose. Our definitions of the past are untenable Bipedal locomotion is the corollary of dynamic posture adding to its complexities The Posture Committee of the American Academy of Orthopaedic Surgeons (1947) defined posture "as the relative arrangement of the parts of the body Qualifying descriptions are added to this limited definition showing a dependence upon body types and their associated variable components. Many definitions may be found in the enormous literature pertaining to posture. One of the most recently published studies by Kendall and Kendall (1952) describes a "standard posture" and refers to their "ideal" posture as *a standard to be achieved* They consider the basis as "one of skeletal alignment" which can be achieved regardless of body type or size This is a tall order and not entirely compatible with natural conditions. For several generations a rigid type of posture concept has frozen

our thinking taking us back to W and E Weber 1836 H Meyer 1873 quoted by Schwartz (1928) together with Braune and Fischer (1889) In all of these studies there has been too much emphasis on a plumb line and a "military standard"

Psychobiologists have contributed a moving concept describing posture as an adjustment chiefly in the erect position (not necessarily standing) as it pertains to problems of locomotion manipulation and gestural communications Maturation and motivation are integrated with learning and skills Posture is thus a species adjustment to the environment, and applies both to the maintained and to the changing relations of different parts of the body to each other and to the supporting media or surfaces. Thus posture enters into almost all behavioral attitudes Supposing man had to think of what he should do with his upper extremities every step he took, as does the chimpanzee who supports his body with his upper extremities during his preferred quadrupedal gait. Instead, man has subordinated his postural activities more and more as he matures until he finally achieves a coordinated reflex stance and locomotion of the highest degree. These neuromuscular and joint mechanisms of man are among his greatest species achievements. He literally stands alone.

Normal posture may be defined as the average or mean of a large number of postural examinations under the same set of circumstances. There would be, within this normal, many other normals if the large group were to be divided into body types Thus the normal for the slender or linear type would differ markedly from the normal for the obese or fat type. But judgment of posture should depend not on the question of slenderness or obeseness but upon the mechanical efficiency of the position. The mechanical study of posture indicates that the disposition of the soft parts and the shoulder girdle by their supporting structures and the position of the joints, as a result of muscle pull and ligamentous support, are either relatively efficient or inefficient The mechanics of the individual must be judged as a whole.

The normal posture for the individual, as opposed to the group normal is the position assumed habitually by the individual. Thus, the group normal would be more clearly defined as *average pos*

*ture* and the *individual normal* as *habitual posture* Habitual posture cannot be determined if the attention of the individual is attracted to his posture, as he will then consciously or unconsciously attempt to correct or change some phase of it. This deviation can, however be observed, as there will be evidence of undue muscle tension or a strained position, rather than the easy relaxation which should be seen. There are many other factors which must be borne in mind such as the time of day relation to meals, and the presence of fatigue.

Standing begins from the ground surface and starts with the feet. Habitual foot posture varies widely and the angle formed by the lines paralleling the inside borders show such marked variation that, in studying the posture of the body as a whole, the feet must be in a predetermined position. Two nearly parallel lines about four inches apart, drawn on the floor serve very well as a guide to position The inside borders of the feet should rest on these lines. The position of the head should be fixed only by having the eyes straight ahead and looking at an object on a level with them. If a mirror be placed several feet ahead and the individual be instructed to look at his own eyes, a good position will be most successfully maintained. His stance can then be examined.

Thus the habitual or mean posture of the individual represents a combination of effects influenced by species adaptation, genetic conditioning and individual responses to behavioral and environmental factors.

**Methods of Determinations.** In order to come by scientifically determined varieties of normal posture large numbers of children, adolescent boys college students and Army dischargees have been examined personally or their posed body build photographs have been classified and analyzed The first edition contained in Chapter VIII the results of examinations of children and adolescents in various preparatory schools near New Haven and at Yale University To these have now been added body build studies of the Army dischargees and special studies of Yale students using a new system of photographic analysis

Army Series A number of laboratories were set up by the Army Quartermaster Corps at separatee centers throughout the country, geographically placed for an objective sampling of the young male population Nearly 100 000 young adult, white and Negro males were photographed and measured by trained Army personnel, supervised largely by Dupertuis and Hooton From this enormous group 40 000 photographs (white males) were selected for the excellence of the photographs without in any way impairing the objectivity of the group This group is probably the largest available for posture study purposes The examination and analysis of these photographs were done in the Statistical Laboratory Department of Anthropology Harvard University under the supervision and guidance of Prof Hooton

Thirty four hundred photographs or roughly ten per cent were selected as a fair sample of the series constituting a workable group for laboratory procedures. Trained classifiers of body types selected at least seven photographs representative of the more than one hundred somatotypes described by Sheldon and modified by Hooton. These were projected by a stereopticon which brought each to a standard ten inch image The lateral photograph was traced onto thin paper This method made it possible to superimpose tracings so as to obtain the mean for each body type. The lumbosacral juncture in each tracing was used as the common point for superimposition. This area was selected because of the relative similarity of soft parts thickness in most persons and because it is approximately the center of the body in the vertical plane

Four samples were chosen to cover the range of all types of body builds with as great a degree of objectivity as possible. Mean tracings were obtained for each group and for each type which were superimposed by independent classifiers, and the final mean tracings were obtained for each general body type.

These standardized photographs as introduced by Sheldon, Stevens, and Tucker and Dupertuis (1940) enable the constitutional type or body build of an individual to be rapidly assayed and to be assigned an accurate rating in terms of the three chief body components,—the degree of fat muscle and linearity This

method of taxonomy depends upon three standard photographs,—full front view lateral or profile view and a full back view—all of which are carefully posed by the subjects on a special turntable.

Values of 1 through 7 were given each body component. Thus an individual who manifested a balanced body build—that is one with neither too much nor too little of each of the three components—was given a 4-4-4 rating

This method of photogrammetry offers a solution to the language difficulty when one is trying to describe with accuracy the body build of an individual Sheldon also approximates the body build determination or rating mathematically An index is arrived at by dividing the height of the subject by the cube root of his weight. This index is then applied to a scale of values, and the numerical rating is obtained Thus observational, mathematical, and descriptive data are reduced to accurate and simple formulae. The anatomical panel, the morphology or the somatotype of an individual can be reduced to a scientific symbol of great value as a descriptive research tool. *An Atlas of Men* Sheldon (1954) is now available for comparative use in these selections

Thus the slightly fat but moderately muscular and tall person would probably rate a symbol expressed as 2-4-4 while the moderately fat, moderately muscular short person would be given a rating of 4-4-2. Descriptive terms rarely convey such exact meanings The complex impression of the body pattern of man in terms of general outlines and composition of fat, muscle, and linearity can be reduced to a symbol, easily handled and appreciated by those who become conversant with the system

**Mean Postures.** The final mean tracing of each body build proved to be astonishingly characteristic of that particular constitutional type. The illustrations speak for themselves and must be considered truly representative. Likewise, the particular postural stance of each body build must be considered a normal for that type of person Only one type the muscular represents our formerly considered "ideal posture" stance. The other types apparently cannot normally assume such a stance It follows, therefore that one should not expect them to do so Each type has its

obvious mean and will resist well intentioned efforts to change. The thin, elongated or linear type cannot assume the posture position of the muscular type and the balanced type represents good posture although it presents a less pleasing appearance than the muscular type

Of course a "mean" is an abstraction and probably does not exist in life, occurring only in statistics. Yet in the sense intended in this study the validity of a mean can scarcely be questioned The four fundamental body types are composites and represent body builds as they really exist in a large sample of the population.

**Percentages in Male Population** The percentages of these four body types as represented in the total series selected were fat type, 10.99 per cent., muscular type, 10 87 per cent., thin-elongated type 18 00 per cent and the muscular balanced or "average-man" type, 26 02 per cent. (The muscular balanced type was the modal type the "central tendency" of the series) The remaining body builds were all grouped under the general classification "intermediate types" (34 12 per cent ) The intermediate types were scattered throughout the 115 somatotypes and represented a distribution ranging between the fat type and the thin-elongated type. They were too few to have statistical significance except that there were no full blown representatives of the three extreme types.

**Components of Stance in Normal Posture.** Part of this theoretically normal posture as has been stated, represents a foot stance showing variations from a perpendicular heel cord line to one of moderate pronation The heel cords must be long enough to allow approximately 15 degrees of dorsiflexion of the foot. The knees are straight with no tendency to a back knee position Five to 10 degrees of hyperextension is possible at the hips without increasing the pelvic inclination In the normal position the brim of the true pelvis is held to form an angle of 60 to 65 degrees with the supporting surface The lumbar spine is slightly concave as measured by a string stretched from the seventh cervical vertebra to the gluteal fold at the sacrum. The dorsal spine presents a slight convexity backwards The neck is forwardly inclined a slight amount be

yond the perpendicular The shoulders are slightly anterior to the line of gravity from the vertex to the head of the astragalus There may be a slight left total lateral curvature, usually due to right handedness (70 per cent) The leg lengths are approximately equal. The chest is slightly depressed, and there is enough relaxation of the abdominal musculature to allow a slight prominence of the abdomen. Thus the low back is nearly flat.

**Best Posture.** The "ideal posture" described by most workers is infrequently seen in untrained subjects The foot stance should be such that the line of the heel cord is perpendicular The knee and hip positions are about the same as in the normal posture. The pelvic inclination is somewhat less (5 degrees approximately) than in the normal posture. The lumbar spine should be flat against a string stretched from the seventh cervical vertebra to the gluteal fold. The dorsal spine should be nearly flat under the string The chest should be moderately elevated in a position midway between full inspiration and full expiration. The abdominal muscles should be contracted to present a flat surface from the symphysis to the ensiform The neck line should be relatively perpendicular The shoulder joints should be in the mid axillary plane of the body There should be no lateral curvature. This posture stance can be achieved by training Its beneficial correlates need no elaboration.

CHAPTER IV

# ABNORMAL VARIETIES OF POSTURE

**Types of Postural Variations.** Variations from normal are of two types (1) those of a functional character and (2) those caused by structural changes either congenital or acquired The latter because of their more fixed character do not yield readily to ordinary corrective measures

## FUNCTIONAL VARIATIONS

**Foot.** There are several types of variations of the feet, associated with body postures. These range from mild pronation to feet that are habitually intoed and occasionally demonstrating a moderate varus Such feet are usually of a character in keeping with the body type of the individual. For example the fat body build usually has a mildly pronated foot but may show a mild varus position with a higher transverse arch The former rarely requires more than simple shoe alteration consisting of an inner marginal wedge for the heel, plus exercises to accomplish satisfactory muscular improvement. In the young adult these variations frequently persist but are usually symptomless

**Knee.** Knee postures may show some slight hyperextension, valgus or varus with each variety usually responding to conservative corrective procedures.

**Hip.** In the hip region a tight tensor fascia lata will produce an increased pelvic inclination and a hyperlordosis A weak gluteus maximus will permit a flexion position of a greater degree accompanied by a tight quadriceps and a flexed knee. These may require stretching or even surgery to release structures under tension.

**Lumbar Region.** The lumbar spine may show increased hollowing, due either to a hyperextension of the lumbar spine (lordosis)

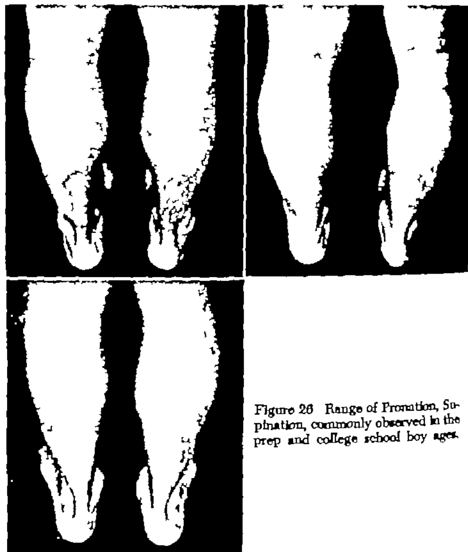


Figure 26 Range of Pronation, Supination, commonly observed in the prep and college school boy ages.

or to increased pelvic inclination. Occasionally there is a decreased extension or flattening with obliteration of the normal lordosis and even a reversed curve in the lumbar region, entirely unassociated with any disorder A prominent abdomen may be present, associated with a flat chest. Exercises can overcome these variations.

**Dorsal Region.** In the dorsal spine, the most common variation is an increased dorsal convexity or kyphosis This is always as

sociated with either an increased lordosis in the lumbar region or an increased forward position of the head and neck. It is usually associated with a flattening of the chest There may be a decreased dorsal curve so that the dorsal region is reversed and appears as a continuation of a long lumbar lordosis A dorsal lordosis and lumbar kyphosis is usually spoken of as reversed spinal curves.



Figure 27 Back knee in adult

**Lateral Curvatures.** Lateral variations of the normally straight spine are quite common In most cases this deviation shows a gentle convexity to the left. This can be determined easily by stretching a cord from the seventh cervical to the fifth lumbar spinous process and then palpating the other spinous processes The one lying farthest from the cord is taken as the point of determination and its distance from the cord is measured. In most cases this deviation is slight and the curve is a gradual one extending throughout the entire length of the spine. Some investigators do not believe there is any correlation with right and left handedness because they find comparatively few instances in which the curve shows a convexity to the right. On the other hand, a correlation may exist between the distribution and attachments of the intrathoracic soft parts to the anterior cervical fascia and the fibrous pericardium These are on the left side. There is certainly no association with small differences in leg length as *leg measurements frequently show a differential, entirely incompatible with the spinal curve*

On the other hand in the Army series studied by one of the authors the spinal curve seems definitely correlated with handedness (70 per cent, right) Shoulder depressions or inequalities relative to the horizontal supporting area most always show a depressed *shoulder* on the side of the hand dominance Since such

or altered foot gear and Denis Browne splints are effective in the latter Less severe postural disturbances such as forefoot adduction supernumerary scaphoids in a pronated foot and persistent cross union of two tarsal bones in a spastic flatfoot, are other postural variants Each produces an altered gait with correlated body postures that are not normal.

The short first metatarsal has been proposed as the cause of postural disorders by Morton (1935) while others, Harris and Beath (1949) deny this as a basis of foot imbalance A close study of over 1500 Greek and Roman sculptures by one of the authors (G) show a short first toe and presumably indicate a short first

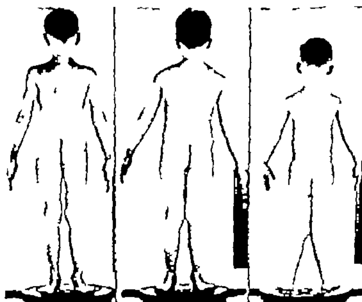


Figure 28 Knock knees Left to right normal moderate; marked.

metatarsal. Is this a true ancient condition? A congenitally short heel cord will be reflected by a back knee and a lumbar lordosis. More children have slack heel cords a probable hormonal effect acquired while in utero This foot stance is reflected in a flexed knee and hip and a forward body position to maintain balance An accessory scaphoid may be accompanied by a moderate pronation Many supernumerary bones of the foot do not seem to

produce postural variations Severe congenital disorders such as extra digits lobster or split foot and amputations must be accompanied by locomotor distress and need no further discussion

**Knee.** Gross anomalies are infrequently observed They may consist of any degree of knock knee or bow legs, back knee or recurvatum A deviation laterally of the normal insertion of the patellar tendon into the tibial tubercle may result in a "slipping

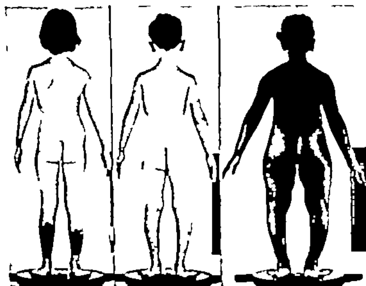


Figure 29 Bowed Legs. Left to right, normal moderate; marked.

patella." This more commonly is accompanied by a knock knee deformity

A contraction of the hamstrings and gastrocnemius is seen in flexion deformities of the knee. This condition is usually due to a cerebral birth injury or to a congenital central nervous system anomaly The severe cases are obvious but the mild cases are frequently overlooked. Careful neurological examination in suspected cases will always reveal other evidence of the condition such as hyperactive reflexes, spasticity and often athetosis The condition is sometimes acquired as a result of an injury or disease such as encephalitis Nervous system anomalies in conjunction with a spina bifida, usually show flaccid feet and diminished

motor control of the lower extremities abduction deformity and sensory changes of varying degrees

**Hip.** Congenital dislocations produce obvious deformities such as a hyperlordosis and a positive Trendelenburg gait. If unilateral, posture is a very awkward affair If bilateral fatigue is produced by the extreme lumbar lordosis There are occasional cases with a shallow acetabulum or a decreased angulation of the neck of the femur with respect to the shaft (coxa valga) which result in an instability of the hip but no actual dislocation. X rays will reveal the difficulty The iliofemoral ligament is relaxed and it is impossible to depend on this structure for balance The iliopsoas and rectus femoris therefore are called into play to preserve balance An unusually short iliofemoral ligament or tight psoas muscle on the other hand prevent full extension and result in an increased flexion of the lumbar spine

**Pelvis.** Congenital abnormalities occur but are of comparatively little importance except those of the sacro-iliac articulations. These produce an asymmetric posture and are accompanied by early fatigue and occasionally by a scoliosis Union of the fifth lumbar vertebra with the sacrum on one side or both (sacralization) will cause limitation of motion in the lumbar spine. Lack of participation of the first sacral vertebra in the sacro-iliac articulation will cause instability of the joint and is usually associated with abnormal ligamentous arrangement. Lack of union of the lamina of the lumbar or sacral vertebrae is only of importance because of associated neurologic anomalies occasionally present.

**Lumbar Spine.** Anomalies of the transverse processes of the lumbar vertebrae are important and are associated with irregular insertions of the quadratus lumborum psoas and erector spinae groups of muscles and allied ligaments necessary for erect stability X ray examination frequently reveals either an extra lumbar vertebra or a twelfth thoracic vertebra without ribs. This condition is seldom of importance unless there is a sixth lumbar vertebra producing a very long lumbar spine The difficulties resulting from this are largely those of support and muscular

deficiencies. A deep lordosis a decreased lordosis or a lateral lumbar curvature may be produced by a hemivertebra. Laterally wedge shaped vertebrae are frequent causes of scoliosis The condition is frequently multiple with half a vertebra on one side at one level, and another half of vertebra at a different level If it is single the curve will during early childhood be a "C" curve and perhaps pass unnoticed but compensatory curves are sure to develop during early adult life These children never show a greater degree of scoliosis but the spinal components of each curve may of course grow longer

**Dorsal Spine** Hemivertebrae are observed with an associated scoliosis. Split vertebrae and mixed developmental disorders may be causes of a kyphosis and a true foreshortening of the thorax. Abnormalities of the ribs such as fused ribs and absence of ribs are seen occasionally and are associated with a structural scoliosis. Deformities of the sternum of congenital origin are correlated with pigeon breast and funnel breast. Both can alter posture. Congenital elevation of the scapula or Sprengel s deformity will show the scapula placed high and tilted forward on a horizontal axis When it is bilateral and not of extreme degree it sometimes suggests a functional round shouldered deformity Abnormalities of the clavicle may cause a structural, round-shouldered deformity

**Cervical Spine** Torticollis may result from a hemivertebra This has been discussed.

**Trauma.** Structural changes as a result of accidents and injuries may be classed under fractures of the bones dislocations of the joints separations of epiphyses sprains or tears of ligamentous structures rupture of tendons and muscles and wounds of the soft parts. These conditions are acute and as such bear no relation to the present consideration except in so far as their permanent after effects are concerned.

The complications arising from fractures and dislocations are either bad deformities from imperfect reduction or shortening and weakening of the muscles from prolonged immobilization.

Limitation of motion of the neighboring joints is the result of shortening of muscles or adhesions from prolonged rest in a cast. In epiphyseal separations such as occur in the hip in older children, results are likely to be severe unless properly cared for

As regards sprains, the results are more indefinite. The chief ligaments involved are the external lateral ligaments of the ankle, the internal lateral ligament of the knee the sacro-iliac and lumbosacral ligaments and the acromioclavicular ligament in the shoulder They frequently manifest a decided weakness of the joints bounded by these ligaments and an undue strain on the muscles controlling the joint. Tendon ruptures and muscle tears, if complete, throw the involved muscle entirely out of function. Partial ruptures cause a decided weakness Wounds and diseases of the soft parts will frequently affect posture because of contractions of scar tissue In cases of empyema with rib resection for drainage of the pleural cavity there is often a scoliosis, maximal in the region opposite the ribs resected. This scoliosis is, however much less in degree than would be expected and may be in either a left or right direction Such a curve is either concave toward the side resected (more commonly) or convex (less commonly) The rib is a rugged bone and re-ossifies too often after resection, unless the vertebral articulation is likewise resected.

**Secondary Environmental Effects.** Structural changes take place in the body as an end result of long continued use in bad functional positions and under unusual stresses and strains The alterations in the shape of the bones likewise alter their mechanical functions and new stresses result. Thus if a lateral curvature is caused by a short leg and consequent lateral tilting of the pelvis, the weight, falling on one side of the vertebral column is greater than that on the other This curve can frequently be eradicated if treated early by raising the shoe on the short side until the pelvis is level. But if the condition is untreated, the vertebrae will eventually become wedge-shaped For example, if the shoe on the short side is elevated to make the legs of equal length and there is no response of the curve toward correction, but instead compensatory curves develop above and below a structural scoliosis is present.

**Foot.** The plantar fascia is ordinarily a relatively unyielding structure taut like a bow string under postural stance of full weight bearing Occupational strains are thought to produce an increased pronation and relaxation of these longitudinal supporting structures Occasionally in older children tight shoes or stockings may be partially responsible for claw toes and contracted feet, ingrowing toenails callouses and corns. These latter pressure disorders respond readily to larger foot gear Short heel cords follow long use of high heels in adult women Accompanying knee and hip as well as total postural strains are very common Models, posing for all prospective customers to see set such awful examples of posture in their high and stylish foot gear that all manner of training in youth is frequently lost in early adulthood to the fashioners The present day fads of ground gripper flat shoes and ballet slippers are partially compensatory

**Knee and Hip** These joints are especially prone to develop degenerative changes of posture with use accompanied by aging Pronated feet cause medial collateral ligamentous strains at the knee. A champion athlete must not have any strain of an abnormal character to compete against or he can never achieve his goals. Unilateral over development of parts is not desirable for similar reasons

**Spine.** Perhaps the classical example of the better known postural variations arising from environmental causes is the rounded back or dorsal kyphosis seen in youths who are overburdened in early life by arduous tasks over a prolonged time span. Agricultural workers, coal mine helpers and very young recruits in the Army were often observed with this structural disorder by Wassmann (1951) The vertebral growth centers were compressed anteriorly and became fixed as wedges The structural nature of the condition becomes apparent by the inability of the individual to straighten the curve

**Shoulders.** The shoulder girdle frequently shows a structural type of forward positioning In the heavily built athletic type, the excessive use of arms as in the average hard laborer shows

a marked overdevelopment of the muscles The shoulders are carried high and forward and the neck appears foreshortened. The dorsal curve is usually not increased in this type and the chest is not flattened while the shoulders cannot be brought down and back to any extent. An individual who is recovering from a long illness or who has been subjected to the privations of war may show drooping shoulders an increasedly round back, flat tened chest and a prominent lower abdomen Old age brings on this type of posture in many instances.

**Behaviorism.** Attitudes of mind are frequently influenced by internal and external factors affecting posture. The depressed individual is easily distinguished from the jubilant one by his posturing Good health and good posture are almost synonymous. A cringing man assumes a totally different posture to that of an outgoing, brave individual. Thus posture often reflects our individual reactions, and status of mind Psychobiologists Riesen and Kinder(1952) emphasize the comparative developmental dif ferences between the chimpanzee and man from birth and demonstrate a remarkable similarity Posture is external evidence of behavioral development. They have appropriately termed their study comparative ontogeny Cultural anthropologists of neces sity make much of assumed "postures" of people, as indicative of levels of development These phases of posture are subjects beyond the scope of this presentation

## DISEASES

**Osteochondroses.** A class of diseases the nature of which is now better known Goff(1954) involves the epiphyseal or growth centers of many bones The most important of these from a pos tural viewpoint is a vertebral epiphysitis or osteochondrosis. In this condition there is a partial failure of growth of the dorsal vertebral epiphyses, especially at their anterior margins where the stress (postural) is the greatest. This usually occurs during preadolescence and allows the dorsal curve to be much exaggerated. If nothing is done about the condition this forward curvature becomes fixed and can be the cause of a marked deformity There

is frequently an associated slight lateral curvature In order to preserve balance there is usually a compensatory increase in the lumbar lordosis This condition is to be suspected when there is not sufficient mobility in extension of the dorsal spine X rays will reveal wedging vertebrae facing forward. This is usually known as Scheuermann s disease. If a single vertebra is affected the disorder is known as Calvé s disease Other epiphyses which may be the seat of a similar process include the hip Legg-Calvé-Perthes disease and the tarsal scaphoid where the condition is known as Köhler s disease

*Pressure epiphyseal* disorders of this type are usually treated by recumbency and freedom from postural stresses. Best results are achieved if such relief is afforded before structurally fixed deformities take place Controlled exercising, non weight bearing, such as swimming becomes the most essential ancillary part of treatment.

**Bone Diseases** Osteitis of the long bones may produce mild deformities. Tuberculosis of the joints usually results in partial or complete immobility of the joint affected. This is of especial importance in the spine. A severe kyphosis was not infrequently seen in former days A gibbosity may still appear in the severe cases. Healed arthritis will also produce limitation of motion in joints, especially in Marie Strümpel s disorder In the hip a flexion contracture may result from a psoas abscess usually associated with a tuberculosis of the lumbar spine.

**Rickets.** Bowed legs are still observed especially in untreated Negro children. They often have a hyperlordosis of the lumbar spine. Scurvy and other deficiency bone disorders are occasionally associated with postural disturbances. Severe tonsillitis may produce an osteitis of the cervical vertebrae with postural loss of the cervical lordosis.

**Poliomyelitis.** Many cases occur which are so mild that they are not recognized at the time The illness passes for an attack of grippe a severe cold or a gastric upset. An almost complete re-

turn of function may occur Mild deformities which are structural in nature may occasionally be observed. Some muscle or groups of muscles may be structurally weak and incapable of full restoration A single muscle or group of muscles may be entirely func

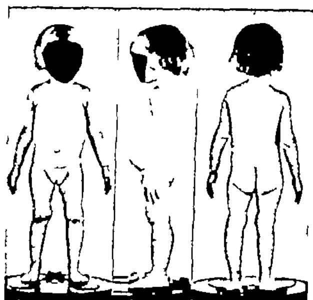


Figure 30 Extreme Pot Belly of Childhood. Case of renal rickets, age six years, stature 31.5 inches, weight twenty-four pounds.

tionless Examples of this condition are a contracted foot, a pronated or supinated foot, and scoliosis In the contracted or cavus foot, the toes are drawn from the ground, the arch is very high and the plantar fascia is tight. The head of the first metatarsal is prominent and often the skin is calloused. Usually the intrinsic muscles of the foot especially the short flexors are very weak. The short extensors contract because of the absence of power in their antagonists. A markedly pronated foot may result from a paralyzed tibialis anticus or posticus Scoliosis follows a partial or complete paralysis of some of the erector spinae muscles of one side with relatively normal musculature on the other side. Careful muscle examination in suspected cases will reveal these paralyses and weaknesses

**Cerebral Palsy** This condition may show many bizarre types of posture

There are, of course many other diseases correlated with structural variations from normal posture A few have been described to indicate probable associations with poor posture.

CHAPTER V

# BODY MECHANICS

## GENERAL PRINCIPLES

An understanding of body mechanics necessitates first a knowledge of the structures, their functions involved in movements together with a knowledge of the distribution of the weight of the body in relation to the center of gravity with each change of position.

The structures involved in bodily actions are the bones joints ligaments, muscles and tendons The bones are relatively rigid structures, supporting the body and acting as lever arms during motions at the joints. Joints are the centers of motion, acted upon by muscles attached to bones The mechanical advantage of a given muscle depends on the point and angle of attachment to the bone and the angle through which action takes place at the joint Ligaments are restraining structures, preventing motion beyond certain ranges, as well as supporting in character in special instances Tendons are continuations of the muscles extending their effectiveness to more distant points. They are an essential part of each muscle but are non-contractile in character

It must be borne in mind that the supporting structures, the legs pelvis and spine as a whole, are not rigid supports that the centers of gravity of the various parts can be shifted with changes of position by muscle action, and that the only mechanical laws applicable are those of *non rigid bodies in unstable equilibrium*.

The study of the mechanics of such bodies must therefore be conducted, theoretically in all possible positions assumed by such non-rigid elements. Just as the mechanical efficiency of a machine is judged by a study of its parts, their correlations and loading conditions, so may the human body in an analogous manner be considered. These will be discussed.

**Regional Components.** In addition to the weight of the body with its parts there are five chief regions which constitute the major part of the load and which determine the position of the center of gravity These are (1) the abdomen and its viscera (2) the thorax and its viscera (3) the movable shoulder girdle including the arms (4) the head and (5) the pelvis

**Abdomen.** The viscera are slung in the forward part of the abdominal cavity and because of their nature and looseness of attachment, act as a load which is forward of the supporting spinal column Such a loading on the vertebral structures is an important factor in postural attitudes The stomach and liver are attached to the diaphragm the suspensory ligament of which is the pericardium notably on the left, and attached to the anterior fascia and the forward portion of the lower cervical spine according to Goldthwait Brown Swaim Kuhns (1952) The liver stomach and heart are therefore slung indirectly from the anterior part of the lower cervical spine Throughout this area there is normally a forward curving of the dorsal column The anterior position of this mass is an important factor in determining the center of gravity

**Thorax.** The chest is a cartilaginous and bony cage the floor of which is the diaphragm It is articulated with the spine throughout the entire dorsal region by means of ribs and constitutes another definitive mass largely forward of the supporting column.

**Shoulders.** The shoulder girdle and upper extremities are not connected by any bony structure to the axial skeleton, other than the movable clavicle, but are slung by muscle attachments The chief support is derived through suspension by the trapezius especially in its upper third. This muscle is attached to the spinous processes of the cervical and upper dorsal vertebrae and the forward position is dependent upon the amount of forward carriage of the shoulders With the shoulders in their normal position and the arms at the sides, this pull is almost entirely vertical On the other hand, the pelvic girdle, it may be noted is fastened to the spine so firmly through the sacro-iliac synchondroses that it may

be considered as a part of the weight supporting structures rather than as a load.

**Cranium** The large head constitutes another forward loading, which actually is balanced rather well in most individuals through a flexible cervical spinal column This latter capacity of man has been delicately adjusted to suit his erect stance through his body righting mechanism that will be discussed later The foramen magnum opens toward the frontal plane and the heavy occipital portion offsets the rather large chewing mechanism of man. Flexion is achieved to a large extent by movements between the second and third and between the fifth and sixth cervical vertebrae. The first motion zone is the site of an occasionally apparent forward displacement in children while the latter region in adults shows the greatest osteoarthritic involvement. The in between vertebrae have some motion but of a limited character Rotation takes place between the first and second vertebrae. Modern man has the greatest, as well as the most graceful cervical curve of all the primates some of whom have almost no lordosis notably the gorilla.

**Spine and Pelvis** Most loads fall anterior to the supporting column although the vertical component in each case is much

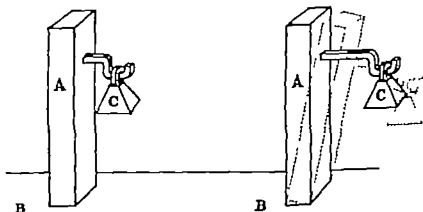



Figure 31 Mechanical illustration of forward loading, showing the effect as a precipitating or falling forward of the top of the column. A. Supportive Column. B Base of Support. C. Load applied as illustrated.

greater than the horizontal component. The loading comes full weight on the sacrum and is immediately directed onto the ilium along a massive bar of bone directed toward the acetabulum.

Diagrammatically the effect of a load forward of a supporting column is illustrated. Here the supporting column is standing in stable equilibrium on a base of support "B." "C" represents a load forward of the column. The tendency to fall forward depends on two factors: (1) the distance of the load in front of the column and (2) the amount of the load. If the supporting column is rigid, the tendency will be to fall as indicated in the dotted outline. The spine, however, is a non-rigid support, and the various distortions resulting from the forward pull of the load constitute the basic conditions inherent in all postural studies. In mechanically efficient stance the forward pull of the various loads described must be reduced to a minimum, thus bringing the center of gravity as near to the supporting column as possible.

**Center of Gravity Line.** Luciani (1915) in experiments on the articulated cadaver has some interesting data on the line of the center of gravity of the various parts. The line of gravity of the head falls in front of the occipito-atlantoid joint as the head, supported on the trunk alone, tends to fall forward. The line of gravity of the head and trunk without the legs falls behind the iliofemoral articulations as these parts alone tend to fall backwards. An apparent inconsistency is easily appreciated when it is realized that the trunk in the cadaver presents quite a different mechanical problem from that in a live body. Also, when supported on the legs, the base is limited to the acetabuli, which are slightly back of the lateral median line of the trunk. The trunk in the cadaver is not supported actively by the erector spinae muscles. During life, on the other hand, the various loads such as the viscera, thorax, etc. are slung from the spine which is a flexible support, made semi-rigid by the action of the erector spinae muscles on the movable vertebrae. Balancing of the trunk on the legs is therefore made possible by a reciprocal action of the iliopsoas and the abdominal muscles acting contrary to the dorsal and lumbar erector spinae muscles and the glutei, with the iliofemoral ligament acting as a

check to hyperextension of the hip joints The hamstrings and other muscles play a modified part by holding down the pelvis.

Lovett (1931) has shown that the body of the cadaver with knees and ankle joints fixed, tends to fall forward. This concept differs from that of Luciani. Goff (1952) has determined the

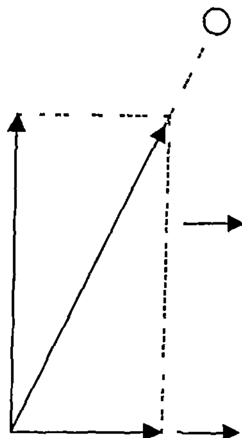


Figure 32. Diagram of Components of Forces, which act on the body in locomotion

center of gravity line on posture photographs of a large army series of white males as passing from the vertex through the external auditory canal, the body of the first sacral vertebra, the center of the acetabulum and the femoral head, to a point just behind the patella and the center of the head of the astragalus.

The feet of the individuals were placed with the heels nearly together as a soldier stands at attention yet at relative ease. Akerblom (1948) and others arrive at these same centers through balancing techniques on scales, using a vertical plumb line.

Mechanics of the Ankle Joint From a purely schematic point of view the ankle and foot joints may be considered as the two main joints. The subastragalar joint between the astragalus and calcaneus as well as the scaphoid and cuboid, afford lateral mobility The ankle joint proper between the astragalus and the tibia and fibula show motion in an anteroposterior plane, allowing plantar flexion and dorsiflexion The weight of the body on the normal foot is chiefly supported by three points, the heads of the first and fifth metatarsals and the heel Actually all metatarsal heads bear a portion of the body s weight. In locomotion the weight is lifted from the heel and transmitted to the heads of the first and second metatarsals with the center of weight in a plane just lateral to the first metatarsal In standing, with the weight distributed evenly on both feet and with the feet three to four inches apart and parallel, a perpendicular dropped from the center of gravity of the body passes in a horizontal plane between the two astragalar heads and not directly through the tibio-astragalar joints This forward displacement of the body weight is counterbalanced by the tension of the calf muscles and the hamstrings The arch is preserved by the tension of the strong inelastic plantar ligaments Lapidus (1932) Rotation of the legs and thighs inwardly from the hips without moving the feet, turns the astragalus with the leg bones, with little possibility of lateral motion in the astragalo-tibial joints. The astragalo-scaphoid and astragalo-calcaneus joints however allow the twist to take effect and the inner longitudinal arch may become depressed Thus the foot is abducted with respect to the leg In rotating the leg outwardly under the same conditions, the apparent height of the arch increases due to adduction of the foot with respect to the leg In the neutral position that is with the axis of the knee in the anteroposterior plane and the patellae in the midline of the leg, the weight should be distributed on the first and fifth metatarsal

heads and the heel resulting in a moderate elevation of the med border of the foot. The distribution of weight on the norn foot is definitely affected by rotation of the thigh and leg w the rotation taking place at the hip joint.

The same mechanical effect may take place in the reverse rection, that is the leg and thigh may be rotated inwardly outwardly by supinating and pronating the foot. Thus the co traction of the tibialis anticus and tibialis posticus not only pinates the foot and raises the medial border from the surface, b also externally rotates the leg and thigh.

The action at the subastragalar joint has been said to be lateral movement but this lateral motion is actually the com nation of several factors There is real lateral motion in t articulation between the astragalus and the calcaneus There also an element of abduction and adduction of the forefoot in t astragaloscaphoid joint and the joints between the scaphoid a the cuneiforms This is also associated with an increase and d crease in the inclination of the arch by a contraction of the sho flexors of the toes It is because of the association of these oth motions with lateral movements that rotation takes place in t leg when the foot is fixed on the ground.

The relation of the weight distribution on the anterior a posterior parts of the foot is a function of balance. If the weig is carried too far forward, by standing with the body tilted fo ward, the greater part of the weight is borne on the heads of t metatarsals while weight on the heel is diminished. In order prevent further tipping forward of the body the gastrocnemi and soleus become tense whereas the anterior muscles, the dor flexors relax. Balance in this position is accomplished by inte action between the forward pull of the body weight and the bac ward stress of the calf muscles with the ankle joint acting as fulcrum If the weight is gradually shifted back, until all or near all is carried on the heels the foot no longer acts as a triangul base of support, but provides instead a single point of suppo Such balance must be accomplished by shifting of the body an arms in order to keep the weight directly over the single point support The dorsiflexors of the foot cannot act in balance e

cept in a very minor degree because the weight on the foot presses the forepart to the ground The only way in which these muscles of dorsiflexion can be made to act in balance would be by extending the base of support backward, as in wearing a pair of skis. Here the dorsiflexors act in the same manner as the calf muscles only in reverse. The soreness felt in the front of the legs after skiing is due to this unusual action on the part of these muscles This same soreness is often felt after prolonged walking and is complained of by track athletes, but here the action keeps the foot in a position of dorsiflexion for clearance in walking and running

Lateral balance is accomplished by means of an entirely different action from that governing anteroposterior balance The base is formed by the area between the two feet and the degree of stability depends on the distance between the feet. Moreover when standing with feet apart, the muscles controlling the ankle joints and subastragalar joints contract very little.

Lateral motion in the body takes place at the subastragalar joints hips and spine. The lateral motion near the ankles occurs almost entirely in the subastragalar joints Their strength and mechanical advantages are too small to allow for the maintenance of equilibrium over an extended time. The maintenance of lateral balance also requires the action of the quadratus lumborum and erector spinae muscles The adductors and abductors of the thigh aid in keeping the soles of the feet flat on the floor The pelvis legs and floor form the sides of a parallelogram when standing, with the pelvis always parallel to the floor

When standing if the hands are placed on the loins above the pelvic brim with the feet three to four inches apart, a very slight shift of weight towards one side or the other will produce a very definite contraction of the lateral abdominals and the quadratus lumborum on the opposite side from which the body is inclined

When standing on one foot, however there is a very definite play of the muscles of the subastragalar joint, throwing the base of support more laterally or medially counteracting the tendency for the body to fall to one side or the other

In standing with one foot in advance of the other the leverage

effect of the contracting calf muscles is much diminished and the balance is maintained by the enlarged base of support. The foot and leg muscles are in equilibrium in this position. The position most used in standing easily for any great length of time is the asymmetrical vertical position, known as hanch The weight is carried on one leg with the knee in the fully extended position and locked The other leg is thrown slightly forward and outward, acting as a prop and bearing very little weight. The foot of the leg bearing the greatest weight is held midway between pronation and supination by a rotation of the body and thigh toward the same side (outward rotation) The pelvis is allowed to drop on the opposite side and all tension comes on the fascia lata, the tensor fascia femoris and the iliofemoral ligament at the hip joint. The body weight is thrown just sufficiently toward the relaxed leg to allow the weight of this leg to act as a balancer In this position there is practically no necessity for balance to be preserved by muscular action below the hips even in the calf muscles It is for this reason that the position is so restful. Of course, the erector spinae and neck muscles have to be in action but, provided the spine and neck can be held erect, this position can be maintained chiefly through tension on the structures named

Vierordt (1915) made tracings of the oscillations of the head in different standing positions by means of a pen attached to a cloth cap tracing the oscillations on a paper fixed horizontally above the cranium It was found, that in the asymmetrical position (hanch) described, there was much less movement of the body in maintaining balance. This should be expected because in this position there is less muscular effort necessary to maintain stability than in any other standing position. However habitual maintenance of this position in individuals who stand a great deal of the time, is likely to produce ligamentous strains because of the asymmetrical distribution of weight. The balance of the body when the weight is borne on both feet evenly is accomplished essentially through tension on the gastrocnemius-soleus group with the body weight carried slightly ahead of the ankle joint, assisted by the anterior tibialis.

Lateral stability is accomplished through forces acting upon the upper end of the parallelogram formed by the pelvis legs and floor and acting in such a manner as to maintain this parallelogram in its rectangular form Lateral balance when standing on one foot, the other lifted from the ground brings into play the action of the supinators and pronators of the foot, but this supination and pronation is so intimately related with internal and external rotation of the femur that it cannot be considered alone.

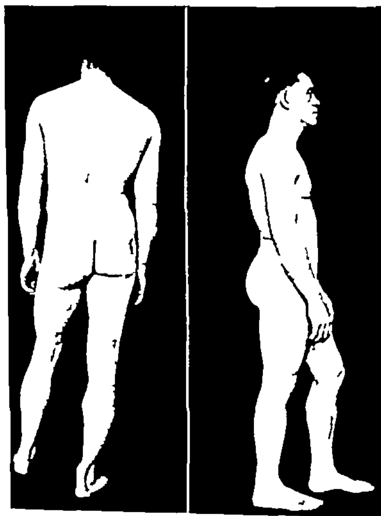


Figure 33 Asymmetrical Standing, called Hanch

It will be discussed further in relation to the mechanics of the hip joint

**Mechanics of the Knee Joint.** In the erect position, feet bare, the knee is fully extended to slightly more than 180 degrees This is not accomplished in normal standing by constant contraction of the quadriceps extensor An examination of the knee in the normal standing position will show that the patella is freely movable and the quadriceps relaxed. The line of gravity of the body in the erect position passes anterior to the knee joint and just behind the patella Thus there is a small horizontal component of the force of gravity acting in the direction of extension which aids in keeping the leg extended without muscle action.

In this position of full extension, there is a slight outward rotation of the tibia with respect to the femur which locks the joint in extension This is the final "screw home" action usually accredited to the knee joint mechanism Hyperextension is prevented by the anterior crucial ligament. Before flexion can take place there must first be an unlocking by inwardly rotating the tibia with respect to the femur This inward rotation is accomplished by the action of the popliteus muscle Flexors of the knee, comprising two groups are attached to the tibia on the medial and lateral aspects and can by acting separately internally or externally rotate the knee, but only in partial flexion so that they play no part in the unlocking rotation which occurs at the beginning of flexion The locked position in standing is maintained by tension on the iliofemoral or "Y" ligament of the hip joint, which is taut when the hips are fully extended.

The maintenance of the erect stance is therefore accomplished, as far as the knees are concerned, by three chief mechanisms the bowstring action of the line of gravity pulling against the anterior crucial ligament and posterior capsule- locking of the joint by inward rotation of the femur with respect to the tibia, and the relaxation of the politeus muscle.

*The functioning relationship between the knee and the ankle joint* is a close one The gastrocnemius in maintaining body balance acts on the calcaneus with the ankle as a fulcrum This

is a two joint muscle spanning the ankle and the knee to the posterior inferior femoral surface There is a definite tendency for the muscle to pull the knee into flexion and out of the locked position Raising the heel from the floor by the ordinary shoe heel throws the body weight farther forward, thus demanding greater extension at the knee to counteract the flexor action of the gastrocnemius which has been shortened. The knee is a relatively inferior joint and quite labile, subject to many injuries and stress arthritis.

**Mechanics of the Hip Joint** The hip is a ball and socket joint and has a wide range of motion Any alteration in either component limits motion Movements in hyperextension are limited by the "Y" ligament and iliopsoas muscle. In all other ranges there exists relative freedom The mechanical aspects of the "Y" ligament are such that it acts as a slightly extensible restraint in the early moments of hyperextension. Hence, in the erect position the resultant strain is forward of the joint and against the resisting ligament. The hip flexor muscles are also fully stretched and probably help in preventing the thigh from going farther into hyperextension. The hip extensors, the gluteus maximus and usually the hamstrings, are relaxed.

Lateral balance is maintained through the antagonistic action of the adductors and abductors, with the spine held erect by the quadratus lumborum abdominals, iliopsoas and erector spinae muscles. The adductors of the right leg function simultaneously with the abductors of the left leg This action serves to maintain the flexible parallelogram of support formed by the pelvis, legs and ground surface

**Mechanics of the Lumbar Spine and Pelvis.** The muscles of the trunk are divided into two large groups The first group contains those muscles which play no direct part in the maintenance of balance while the second group is concerned with balance. Just as the muscles of the arms aid in maintaining balance, while standing on a narrow base of support, but play no part in the ordinary position of erect posture.

All the trunk muscles, except the intrapelvic and perineal muscles play an important part in balance. The dorsal groups acting together extend the spine the ventral groups flex the spine. Acting separately the dorsal and ventral groups on one side oppose the same groups on the other side. These muscles during erect stance, keep the line of gravity centralized.

For practical purposes, the pelvis can be considered as the lower base of the spine. The amount of motion in the sacro-iliac articulations is very small Thus schematically the joint between the sacrum and ilium may be shown in a fixed, right angle position. When the legs are of the same length and the ground is flat, the pelvis is considered parallel to the latter surface. If one leg is raised by a block, the pelvis is tilted upward on that side. The right angle joint, between the pelvis, sacrum and spine however remains fixed and the spine curves convexly in a direction opposite to the tilt attempting to maintain the center of gravity between the feet. Associated with this action is a movement of the pelvis and body laterally made necessary to bring the weight again equally on both feet. Such a position is retained by the active participation of the adductors of the lifted extremity and the abductors of the opposite leg Stability is further maintained by contraction of the muscles attached to the brim of the pelvis on one side as against the muscles pulling downward on the brim on the opposite side. Those directing their energy upward are the latissimus dorsi, erector spinae multifidus spinae external oblique, internal oblique and the quadratus lumborum The tensor fasciae latae, gluteus medius and minimus are down pulling muscles together with abduction of the thigh acting in the latter capacity when necessary The muscles, pulling the opposite side of the pelvis upward are the lateral flexors of the spine.

The hamstrings, consisting of the biceps semi-membranosis and semi tendinosus tend to rotate the front of the pelvis upward assisted by the rectus abdominalis The gluteus maximus also acts in this capacity but more directly by a downward pull on the back of the pelvis The upward pull on the pelvis by the rectus abdominalis causes a rotation of the pelvis when the gluteus maximus and hamstrings produce a downward pull on the ischium This

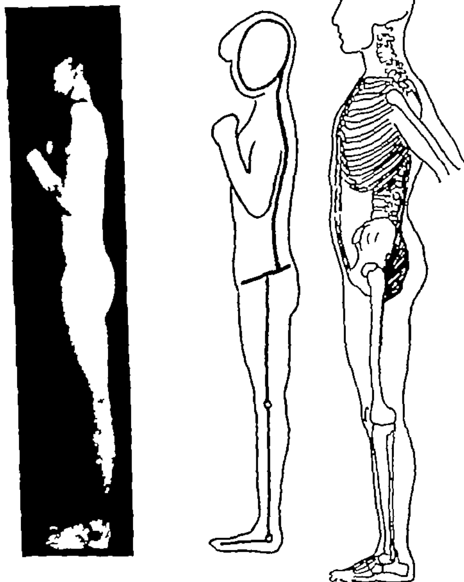


Figure 34. Illustrating forward and upward rotation of pelvis by contracting the abdominal and gluteal muscles, relaxing in part, the posterior spinal muscles.

rotation causes a flattening of the concavity of the lumbar spine. The muscles acting in the *opposite direction, tend to rotate the* front of the pelvis downward and backward, increasing its angulation. These are the psoas, by direct action on the lumbar spine, the *iliacus, sartorius and the rectus femoris* The normal angle of inclination is such that the plane of the brim of the pelvis is about 60 degrees with the horizontal By the pull of the rectus abdominalis and the gluteus maximus and hamstrings the inclination can be decreased 10 to 15 degrees, and by a contraction of the rectus femoris, psoas and iliacus with the erector spinae, quadratus lumborum multifidus and interspinalis the inclination can be increased by about the same amount. Naturally there is a tendency to knee flexion when rolling the pelvis upwards. In the mid position the muscles are maintaining equilibrium It should be borne in mind that pelvic rotation produces an increase or a decrease in the lumbar lordosis.

**Mechanics of the Dorsal and Cervical Spine.** Lateral motions of the upper lumbar dorsal and cervical spine constitute a continuation of the lateral motions of the lumbar spine but to a lesser degree. Lateral mobility of the dorsal spine is markedly limited due to the thoracic cage and its mechanical difficulties in the approximation or separation of the ribs. The attachment of the quadratus lumborum to the last rib and the attachments of the rectus, the external and internal obliques laterally to the sternum and ribs provide leverage action equal to the depth of the thoracic cage When voluntary lateral flexion of the spine takes place, there is a pull exerted on the lateral areas of the spine by the multifidus spinae and other rotators. The same side of the thorax is acted upon by the external and internal obliques and the quadratus lumborum. This pull is somewhat eccentric and tends to produce a rotation of the spine in a direction opposite to that of the lateral flexion, unless this rotation is prevented by simultaneous contraction of the opposite rotators

Anteroposterior stability is maintained by interaction between the abdominals in front and the erector spinae multifidus rotatores and interspinales acting posteriorly The weight of the tho-



Figure 35 Illustrating failure to rotate pelvis forward but instead the lumbar lordosis is greatly increased, dumping the pelvis. The abdominal and gluteal muscles are less forcefully contracted.

racic and abdominal viscera is applied forward of the spinal supporting column These viscera are slung indirectly from the cervical spine exerting traction forward and downward on the upper dorsal spine. Voluntary extension of the dorsal spine is possible. It is accomplished by contractions of the extensor muscles of the back, and by elevation of the thorax through the actions of the intercostals the levator costals and the *serratus posterior* muscles. The scalenius anterior elevates the first ribs Such a position cannot be maintained for long

It is well recognized that in active exercises of any type greater bodily efficiency can be attained by holding the thoracic spine in the more extended position. Elevation of the thorax increases total lung capacity by permitting the diaphragm *to function* through a greater range Contraction of the erector spinae muscle groups pulls the head upward and backward, thereby increasing the facility of breathing by straightening the trachea. Drawing the viscera upward by the "suspensory ligament" of Goldthwait, when the head is more erect, eases the load on the diaphragm Proportional contractions of the intercostals *affords* a firmer base for the action of the serratus groups which in turn stabilizes the scapula and allows the deltoid to expand all its energy on the humeral lever instead of wasting part of it tilting the acromion downwards. As will be explained this combination also provides a firm foundation for the action of the serratus and trapezius in elevating the arm beyond 90 degrees *from the* side of the chest wall

**Mechanics of the Shoulder Girdle and Arms.** Movements *of the* scapulae are restricted by the limiting clavicular strut, which also keeps the extremities from being displaced forward. The sternoclavicular joint is the main joint between the trunk and *the upper* extremity mechanism It is practically a universal joint with motion taking place between the clavicle, an intra articular disk and the sternum *Ranges of motion of the scapula are further* increased at the acromioclavicular joint. If the clavicles were fixed at both ends it would be impossible for the shoulders to function Many quadrupeds do not have *and need no clavicles*

Motion of the clavicle is largely rotary in character It actually moves somewhat vertically, directed slightly forward at its upper edge when the shoulder is raised and backward along its lower edge during the act of depression. Moving the shoulders backward and upward as well as forward and downward permits the clavicle to glide upon its joint surfaces at both ends

Rotary movements of the scapula round the acromion as a center are produced by the action of the serratus muscles with very little motion of the clavicle, as in raising the arm away from the side Elevation of the shoulder girdle is produced by contractions of the rhomboids levator scapulae and upper trapezius This movement produces rotation at the sternoclavicular junction This is exemplified in scapular movements during rowing Here the arm moves in the sagittal plane but the scapula rotates mainly around its superior pole, especially at the end of the stroke. The scapulae may also be brought nearer together posteriorly in which case they are depressed The musculature controlling all these movements arise from the scapula and are attached to the thorax or spinous processes of the dorsal and cervical vertebrae Hence in movements of the scapula, it is necessary that the thorax and dorsal spine be stabilized.

Motion picture studies of arm exercises show that the dorsal spine is held quite erect and the center of gravity of the cranium is directly over the center of the cervical vertebral curve. The position of greatest economy which at the same time allows fullest play of the shoulder girdle and arm muscles is therefore the fully erect position with the neck nearly perpendicular and the thorax elevated. The dorsal erector spinae muscles as well as the cervical muscles, can act with greatest efficiency when the summation of their actions is in a nearly straight line

This same synchronization of muscles occurs during powerful use of the arms The scapulae are held down and the shoulders somewhat back of the midline to allow for most economical action. There must be both a steadying effect on the point of origin of the arm muscles and a position of greatest effectiveness for the contraction of the shoulder girdle muscles during movements of the arm The function of many of these shoulder girdle muscles,

as accessory muscles of respiration, indicate the need for their coordinate action during heavy exercise The clavicle further stabilizes the shoulder and aids in keeping the upper extremity at a proper distance from the trunk. Therefore, in animals in which no such combinations of movements exist, the forelimbs are used only for progression

The only ligaments attached to the scapula are those connecting it with the clavicle or the humerus There are no other ligamentous structures attached to the shoulder girdle

The scapula is usually thought of as suspended from the trunk by muscular slings This is very different from the situation in the lower extremity where the pelvis is firmly attached to the trunk by means of the sacro-iliac synchrondroses In quadrupeds, the body is slung between the scapulae by the two serratus muscles which take origin on the ribs In man s erect position on the other hand, the serratus is an activator of the scapulae and aids in elevating the arm beyond 90 degrees. The levator scapulae, the rhomboids the upper trapezius and the omohyoid muscles, as has been stated, aid in suspending the upper extremity The trapezius and rhomboids also arise from the ligamentum nuchae the nuchal line and the spinous processes of the seventh cervical to twelfth dorsal vertebrae The lower part of the trapezius, of course has no supporting function The weight of the arms tend to increase the forward dorsal curve if they are carried too far forward. When however the shoulders are drawn backward, much less energy is expended by the dorsal erector spinae muscle groups in maintaining such an erect posture. An ache in the back of the neck and dorsal spine apparent after walking a long distance in a heavy overcoat, is due directly to the increased load of the coat added to the normal weight of the arms

Therefore a considerable loading takes place of the lower cervical and upper dorsal spine, by the weight of the abdominal viscera and the weight of the shoulder girdle and arms These are counteracted by the extensor muscles of the upper dorsal and cervical spine with the expenditure of energy decreasing rapidly as the spine is held more fully erect.

Mechanics of the Head and Neck. The convex *forward cervical* curve maintains the head in a position in which the line of vision usually is parallel to the ground This enables the heavy head to be balanced over the center of gravity in good posture. Any in crease or decrease in the dorsal curve is compensated for by a corresponding increase of the cervical curve There is a large

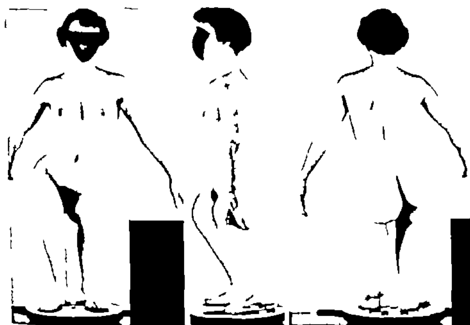


Figure 38 Illustrating Body Righting Mechanism. A young woman, with numerous anomalies of upper and lower extremities, maintains good bodily posture in spite of her limitations

amount of motion possible in all directions in the upper cervical region. This curve practically never is lost except in diseased conditions—Marie Strümpel arthritis

To repeat for emphasis rotation of the head occurs between the atlas and axis Lateral flexion takes place throughout the cervical spine, below the axis Forward flexion of the head, as well as extension, takes place chiefly between the second and third and the fifth and sixth vertebrae Cinefluoroscopy has es tablished these regions as the zones of greatest motion and hence the all too frequent site of *use arthrosis*

The head may be shifted slightly in any direction to maintain balance when the body is supported on a narrow base, but the associated disturbance of vision and of equilibrium tends toward returning the head to a balanced or neutral position, irrespective of the position of the rest of the body This act is concerned with the body righting mechanism peculiar to man

**Locomotion Mechanics** This is not discussed in detail. Volumes have been written and remain to be written. Many laboratories are hard at work analyzing this very complex function of many bodily parts Research is progressing at Yale University Medical School and elsewhere that will someday bring these mechanisms into better focus

**Laws of Squares and Cubes** First proposed by Bergman (1847) this law indicates that nearly all evolutionary changes of species are accompanied by changes in body size Bergman explained these changes of proportions by pointing out that organs which function as surfaces such as skin intestines, lungs, cortex of bone, etc., increase as the square while the bulk of the body is cubed. Thus a femur whose surface area is the square of man s femur will support a weight that is the cube of the man s weight. This explains the relatively small femur of great apes in relation to their great body weight.

Many other elements of body mechanics might be discussed but enough has been presented to start the reader thinking The rest follows in trace.

CHAPTER VI

# POSTURAL EXAMINATION

PHYSICIANS are usually the first to see the child during these days of pre-school examinations conducted in most educational systems In high schools preparatory schools and colleges an orthopedic specialist usually examines the students when they are admitted. These medical examiners must have more knowl edge of posture as related to good body mechanics than is usually available to the casual physician. This monograph is oriented toward these examiners with the full realization that they are receptive, understanding guardians of the health of young people prepared to apply new information which will aid them in their difficult tasks related to postural detection and correction

Purpose The aim of a postural examination should be the assaying of all functional parts relative to the presence or absence of good body mechanics A superior knowledge of the construction and mechanics of the body with its variations from normal, both structural and functional, has been emphasized. In addition, since corrective work is often carried out in groups or classes in physical education the examination should be rapid. Usually such a study should be made separately rather than as a part of a general physical examination, so that the examiner may concentrate on postural aspects This is especially true where large groups are concerned No corrective work, however should be undertaken until the information obtained during a complete physical examination and the past history of the individual are correlated with the examination by the physical educator Definite standards should be adopted and examinations should usually be made by the same individual. This is especially true if statistical evaluations are to be recorded for comparative results of corrective measures to be instituted

The determination of the degree of variations must be accurate

and allowance must be made for the time of day and degree of interest expressed by those under study

Methods Lee and Brown (1923) in the examination of Harvard students divided posture into two groups good and bad, with a subdivision of each into good and fairly good for the first and bad and very bad for the second types In addition, the individuals were divided into the heavy intermediate and slender body types This division into types is of great value, especially in the physical rating of the individual, lending itself to research projects related to body build and correlations thereof

A similar method, developed to a much higher degree and valid in character as far as gross implications are concerned, is that of Sheldon, modified by Hooton and used by one of the authors in a large army series of body build studies notably of posture, to determine ranges of normal In this regard the postural examiner whether a physician, athletic director or physical therapist, must be well aware of a relatively mean population disposition of bodily parts and stances thereof—a "normal posture" for each of the common body types. While difficult enough to achieve by statistical methods a selective system developed by the army and perfected in the laboratory of Professor Hooton of Harvard University offered just the right opportunity to systematize postural means or averages Some 115 body types were determined by skilled body typers using a three-view posed photograph and anthropometric values were recorded at the same time by a trained team of examiners These body build photographs were enlarged to a common size and traced in outline together with the upper extremities. These outlines were superimposed using the center of the lumbosacral curve as the common correlation point. Fresh tracings were made of the mean of these drawings and a composite body build outline was obtained for each main type. These young male adults were all regular dischargees No disabled were included They had been screened many times by the army methods and survived the most difficult of all wars to-date They were successful soldiers and men They had survived their ordeal. Who is to say they were not fit fellows,

yet observe their outlines The best efforts of the experts had been at work producing the results obtained These mean postural results are not ideal but they were proven fit for environmental conquest Some value must be given them when considering posture in general.

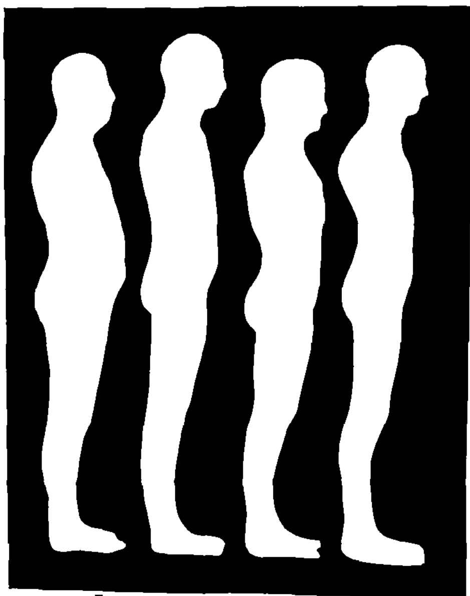


Figure 37 Mean Posture Patterns, army series.

A similar system of three constitutional or body build posed photographs are taken of children at Newington Home and Hospital for Crippled Children. They are rated by the same method

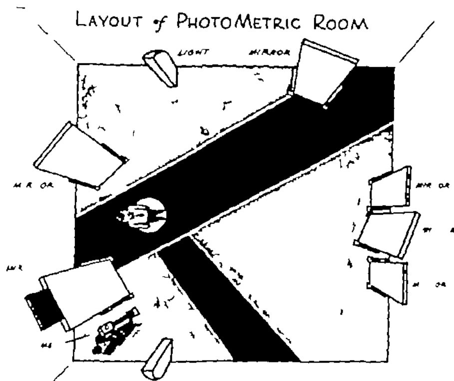



Figure 38 Layout of Photometric Unit used at Yale University Department of Physical Education.

Former methods used at Yale University under the aegis of one of the authors have been modified. These postural evaluations using a relatively new system of posed photographs are determined of all Yale freshmen early in their physical education program. Others are taken near the end of their course and values are recorded. In this system four photographs are obtained simultaneously using mirrors placed at measured angles from the camera. Later by projecting these images on a one-half sized screen measurements are possible within a tolerance of 0025 of an inch on an image thirty-six inch

Subjectivity has been high in all methods heretofore depending upon the bias of each rater Silhouettographs introduced by Fradd (1923) at Harvard, have the dubious merit of denying the use of body landmarks. Cureton (1931) raised the rating reliability by introducing the conformator still used in the armed forces research laboratories to a great degree of proficiency Wellesley College women were appraised by MacEwan and

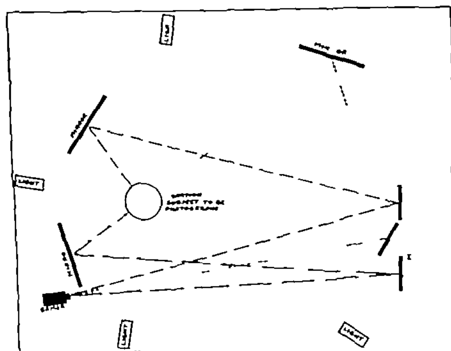



Figure 39 Camera Room Layout.

Howe (1932) by using full body photographs, indicating the point on the back where each spinous process was located by means of aluminum pointers of various lengths The curves of the spine were easily noted and measured on the lateral photograph. Postural relations were recorded Wickens and Kiphuth modified this technique and used it for many years Many other systems using photogrammetric methods have been tried, most of them successfully

**New Yale Method** Recently the Photometric apparatus was put to use at Yale University This method was developed by the tailoring industry and its use expanded to include anthropometric determinations in industry medicine and physical education. The equipment provides four images of the individual in one exposure and enables the recorder to have a complete pic

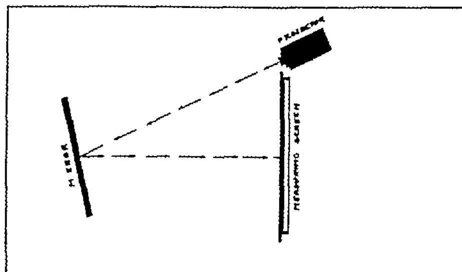



Figure 40 Screen Room Layout.

ture of the subject in front rear side and overhead views The subject is posed on a special turntable, standing erect at ease with the feet about four inches apart.

After an exposure is made, the camera mechanism automatically draws the exposed film into the magazine and the unexposed film is drawn into position. One roll of film takes fifty exposures, so the procedure may be completed very rapidly However the complete roll of film need not be used before removing the exposed film from the camera. The magazine containing the exposed film can be removed at any time, leaving the unexposed portion of the roll in the camera

A lantern slide is made of each exposure so that the image may be projected to half life-size on a screen and accurate measure-

ments of any part of the body may be made Various desired dimensions which are too small to be made on photographic prints can now be determined with reasonable assurance of accuracy




Figure 41 Four views taken at one exposure by the Photometric Unit. Markers have been placed as described in the text, and lines drawn according to method used in postural analysis.

In preparation the individual has the following landmarks indicated by—

I Flesh pencil markings on the body

- A. Left side
  1. Tragus of ear
  2. Tip of acromion
  3. Greater trochanter
  4. Head of fibula
  5. External malleolus
  6. Cuboid bone of foot
- B Posterior surface
  1. Spinous process of all vertebrae from seventh cervical downward
  2. Root of the spine of each scapula
  3. Inferior angle of each scapula
  4. Posterior superior spines of ilia
- C Anterior Surface
  1. Anterior superior spines of ilia
- D Top of Shoulders
  1. Acromioclavicular joint

II Aluminum pointers are placed on the body by adhesive tape at the following locations

- A. Posterior surface
  1. Spinous process of seventh cervical vertebra
  2. Point of greatest convexity in upper back
  3. Point of inflection between dorsal and lumbar curves
  4. Point of greatest concavity in lower back
  5. Prominence of the sacrum
  6. Posterior superior spine of left ilium
- B Anterior surface
  1. End of sternum
  2. Anterior superior spine of left ilium
- C Left side of body
  1. Tip of shoulder

**Recording Measurements.** The slide is first projected onto the screen Then marks are placed on the screen to indicate where the ends of the pointers actually fall on the body This is done by measuring in from the free end of each pointer the length of

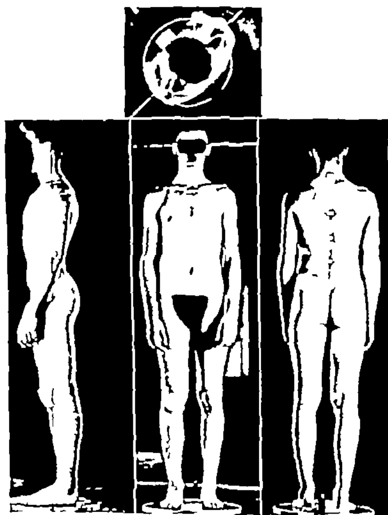


Figure 42. Subject one. Before training.

the pointer After all the points are located on the screen, measuring is begun on the lateral view with a specially designed protractor ruler to determine for consistent correlations those angles which have been used in former Yale programs

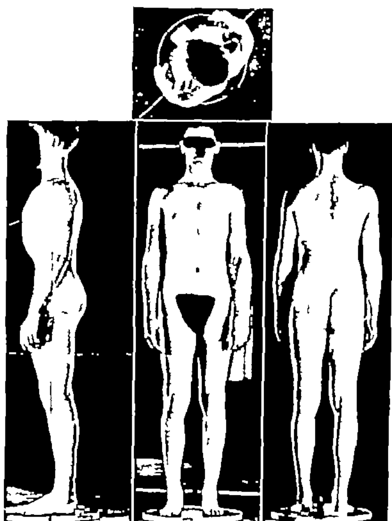


Figure 43 Subject one. Six months later

1 Head and Neck Position—Angle A.

The position of the head and neck in relation to trunk is determined by scaling the angle formed by a horizontal line running through the seventh cervical vertebra and a line drawn from that vertebra through the tragus of the ear The size of this angle will vary as the head is thrust for ward and backward, and the more the head is thrust for ward the smaller the angle will be.

2. Kyphosis (Roundness in the Upper Back)—Angle B

The amount of curvature of the upper back is found by scaling the angle which is formed by a line drawn through the point of greatest convexity and the seventh cervical vertebra and a line from the point of inflection between the dorsal and lumbar curves The greater the roundness of the upper back, the smaller the angle will be.



Figure 44. Subject two Before training.

### 3 Lordosis (Hollowness in the Lower Back)—Angle C.

The curve in the lower back is determined by scaling the angle formed by a line through the greatest concavity and the point of inflection and a line between the point of greatest concavity and the prominence of the sacrum This angle of concavity will become smaller as the hollowness becomes greater

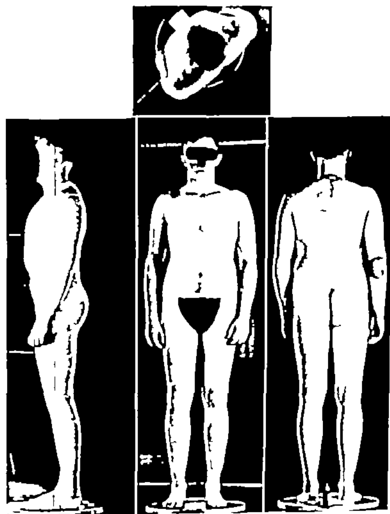


Figure 45 Subject two Six months later

4 Overcarriage (Backward Tilt of Trunk)—Angle F

The position of the trunk in relation to the hips is ascertained by measuring the angle formed by a horizontal line through the prominence of the sacrum and a line from that point through the seventh cervical vertebra As the trunk begins to tilt back over the hips this angle will approach or surpass a right angle.

5 Chest Carriage—Angle E

The position in which the chest is carried is disclosed by scaling the angle formed by a horizontal line through the seventh cervical vertebra and a line drawn from the end of the sternum to the seventh cervical vertebra. The higher the chest is carried the smaller the angle will be

6. Hip Thrust—Angle I

The position of the hips in relation to the feet is determined by measuring the angle formed by a line drawn from the cuboid bone through the greater trochanter and a horizontal line through the greater trochanter As the hips are thrust forward, the angle becomes smaller

In addition to the above measurements used previously at Yale certain other considerations were studied.

1 Linear Measurements.

The half life-size image makes it practical to measure certain linear distances Two such measurements are being taken the horizontal displacement of the tragus of the ear from the seventh cervical vertebra (aa) and the linear distance from the tragus of the ear to the seventh cervical vertebra (bb)

2. Pelvic Tilt.

Two angles are being measured on the anteroposterior view to determine the more significant indicant of pelvic

tilt. The reference points on the left side for both angles are the anterior superior spine of the ilium, posterior superior spine of the ilium, and the greater trochanter of the femur. The anterior superior spine of the ilium serves as the vertex for the first angle—Angle G, while the posterior superior spine is the vertex for the second angle—Angle D.

3. Shoulder Displacement

The relationship of two different angles to the shoulder position is being studied. One angle is proposed as an in

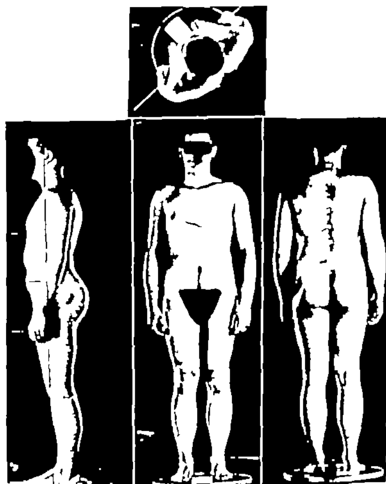


Figure 40. Subject three. Before training.

dicant of abduction of each scapula whereas the second angle shows scapular tilt Both angles are measured on right and left sides The first angle is defined by a line from the inferior angle of the scapula to the seventh cervical vertebra and a vertical line through the vertebra—Angle K. The angle of scapular tilt is formed by a line from the inferior angle of the scapula to the root of the scapula and a vertical line through the root—Angle L. Care is exercised to insure that the subject stands with scapulae in same position for marking as for the photographic rec

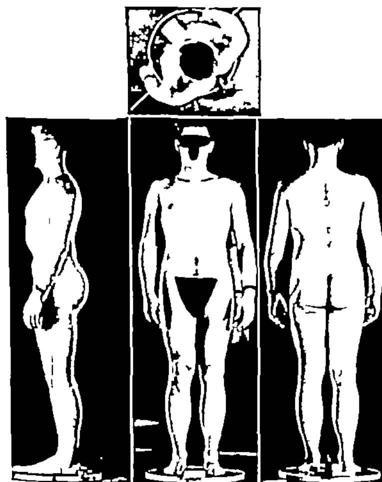


Figure 47 Subject three. Six months later

TABLE I

POSTURAL MEASUREMENTS

| | | SUBJECT 1 | | SUBJECT 2 | | SUBJECT 3 | |
|---|---|---|---|---|---|---|---|
| | | *October* | *March* | *October* | *February* | *October* | *March* |
| ∠A | Head and Neck Position | 60 | 61.5 | 50 | 58 | 55 | 55.5 |
| | aa. Linear Measurements | 3.5 | 3.4 | 4.3" | 3.4 | 3.35 | 3.75" |
| | bb. Linear Measurements | 6.8" | 7.25" | 6.5 | 6.1" | 5.7" | 6.7" |
| ∠B | Kyphosis | 150 | 158 | 148 | 153.5 | 153.5 | 162.5 |
| ∠C | Lordosis | 148 | 172 | 153 | 163 | 147 | 161.5 |
| ∠D | Pelvic Tilt—1st Angle | 48 | 53.5* | 44 | 50 | 45 | 47 |
| ∠E | Chest | 48.5 | 43 | 49 | 46.5 | 53 | 40.5 |
| ∠F | Overcarriage—1st Angle | 87 | 86.5 | 85.5 | 85.5 | 81.5* | 86 |
| ∠G | Pelvic Tilt—2nd Angle | 52.5 | 53 | 51.5 | 57 | 72.5 | 66.5 |
| ∠H | Overcarriage—2nd Angle | 88 | 90.5* | 89.5 | 90 | 90.5 | 90 |
| ∠I | Hip Thrust | — | — | — | — | — | — |
| ∠K | Scapular Abduction | | | | | | |
| | aa. Left | 16 | 20.5 | 10.5 | 21.5 | 25 | 26 |
| | bb. Right | 21 | 21.5 | 18.5 | 20 | 20 | 24.5 |
| ∠L | Scapular Tilt | | | | | | |
| | aa. Left | 5* | 15 | 6.5 | 18 | 70 | 14 |
| | bb. Right | 3.5 | 11 | 3.5 | 13 | 40 | 12 |
| ∠M | Shoulder Displacement—1st Angle | 145 | 145 | 143.5 | 143 | 140.5 | 141.5 |
| ∠N | Shoulder Displacement—2nd Angle | 77.5 | 75.5 | 72 | 74 | 68 | 69.5 |

ord Otherwise, the markings for the scapular points may not be directly over the actual points in question

Any indication of a forward shoulder position is readily discernible in the overhead view In this photograph, the 2 angles are measured that are formed by lines from the left acromion to the seventh cervical vertebra and from the latter to the right acromion as Angle M a second angle composed of lines from the left acromion to the seventh cervical vertebra and from the latter upward and down ward through the spinous processes This is Angle N

4 Overcarriage—Angle H

This angle is formed by a horizontal line through the greater trochanter and a line from the latter to the seventh

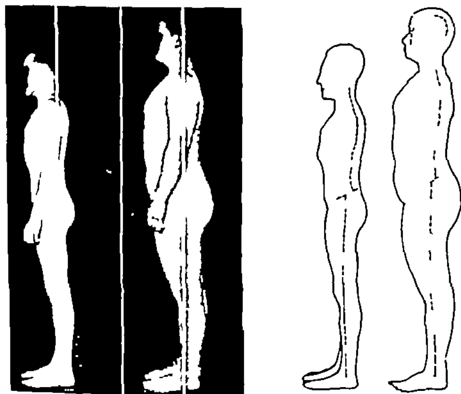


Figure 48. Excellent Posture Outlines drawn on right to show manner of balancing.

cervical vertebra. Inasmuch as the greater trochanter also serves as a reference point for measuring hip thrust, the use of this angle to indicate overcarriage facilitates comparisons of the trunk with the legs.

**Classification.** Postural ratings are divided arbitrarily into four classes those with no defects those who show mild indispositions a group manifesting moderate defects and a much smaller division of those who have greater to gross disorders of posture. Among these classes a regional rating might be further considered relative to their zones of deviation from an accepted normal posture.

**Neck.** *The cervical spine normally has a slight forward inclination* which is the upper end of the normal spinal curve. The structure of the soft tissues and muscles about the neck is such however that the line of the front of the neck from the chin to *the sternum is approximately vertical when the body is in good* posture. This line can be tilted forward from the perpendicular either by an increase in the dorsal curvature, especially in its upper portion or by a sagging of the ribs and thorax, thus lowering the sternum and moving it backwards. As these two conditions are usually associated a tilting forward of the anterior neck line results The degree of tilting whether it be mild, moderate or marked must be duly rated Attempts have been made to measure the amount of forward tilting in terms of the angle formed by the neck line with the perpendicular but the difficulties are great, due especially to the shortness of the neck line The determination of the posterior neck line is of less value because it is obscured by the thickness of the trapezius and usually curves backward toward the occiput. The result is not a straight line at all but a continuous curve concavity backwards. If any part of it is straight it may serve as a check on the location of the line of the anterior curve as it tends to parallel it in general. The position of the mastoid with regard to the acromion of the shoulder is valueless because of the mobility of the shoulders

**Shoulders.** The position of the shoulder girdle is such that in the

ideal posture the plumb-line from the tip of the mastoid should pass through the tip of the acromion There are however exceptions. If the head is carried forward then a perpendicular line passing through the tip of the mastoid will pass well in front of the shoulders even in marked degrees of forward shoulders An examination of the distance between the scapulae, viewing the body from the back will often be of assistance The degree of

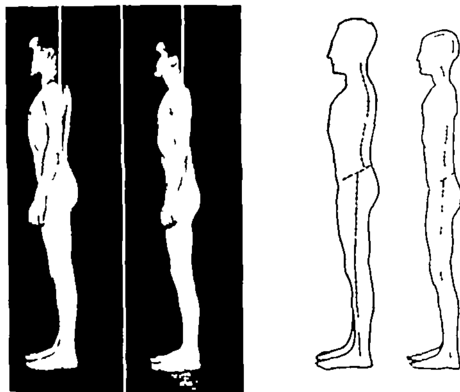


Figure 49 Excellent Posture

elevation of the shoulders is important. If the examiner stands directly behind and looks downward over the shoulder the line from its tip to the sternum below the clavicle, will be observed When the shoulders are in their normal position this line should be practically straight, but when the shoulders are forward, it becomes curved. The degree of forward shoulders is less than is apparent at first glance if there is an increase in the dorsal spine

convexity Bending forward of the upper back and neck will frequently give the appearance of forward shoulders when they are practically in their normal position This can be ruled out by diminishing the dorsal curve and noting forth the shoulders, assuring that their position relative to the spine does not change.

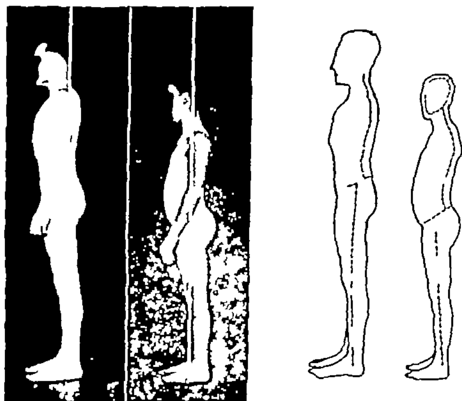


Figure 50 **Left photograph and drawing—**Excellent Posture **Right photograph and drawing—**Good Posture. Mild forward neck, weak lumbar shoulders, moderate dorsal kyphosis and lumbar lordosis, *abdomen protruding* No overcarriage.

The position of the clavicle should be observed. The clavicle is of course more prominent in thin individuals but its relative prominence is such that, as the forward position of the shoulders increases the prominence of the clavicle becomes greater It should be borne in mind that forwardly placed shoulders can be associated with either elevation appearing as a foreshortened

neck in the overdeveloped athlete or as a depression of the shoulder when the trapezius is weak. This is often associated with an increased dorsal curve

The height of the shoulder girdle is dependent on the development of the trapezius and of course to a lesser extent on the development of the levator scapulae A type of individual oc-

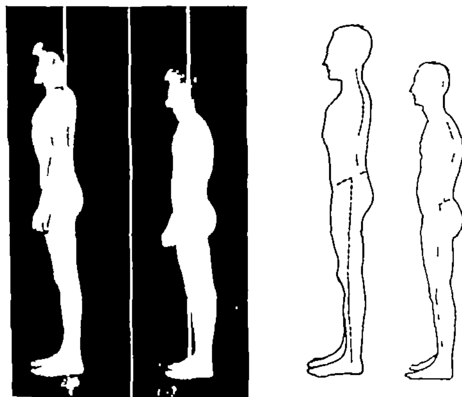


Figure 50 Left photograph and drawing—Excellent Posture. Right photograph and drawing—Good Posture. Moderate forward neck, normal shoulders, fair dorsal kyphosis, fair lumbar lordosis, no increased pelvic tilt, abdomen flat, chest flat, no overcarriage.

casionally encountered will give the appearance of possessing an extremely long neck. Further examination will reveal that the scapulae are in a very low position on the thorax. A very much more normal relation of the head and shoulders can be obtained by a voluntary contraction of the upper trapezius and shoulder

elevators The trapezius strength is not normal in these cases When it has been strengthened by a course of exercises, the shoulders will tend to return to a more elevated position.

As has been mentioned, the other extreme is the very well developed individual with an apparently short neck. In this type the overdevelopment of the trapezius and levator scapulae is obvious Neither are necessarily associated with a forward shoulder position, although frequently both postures may be found in the same person.

**Dorsal and Lumbar Curves.** A study of the spinous processes of the dorsal and lumbar vertebrae will show that those of the first and second dorsal region are perpendicular to their lamina Grad

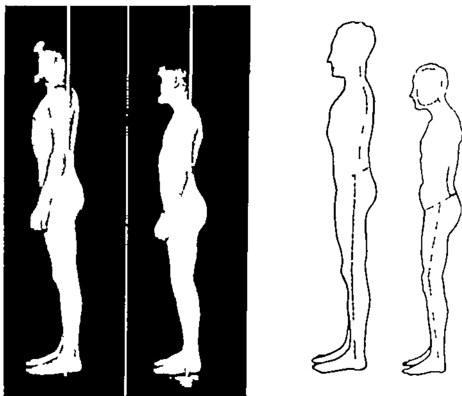


Figure 52. **Left photograph and drawing**—Excellent Posture. **Right photograph and drawing**—Good Posture. Forward neck, good shoulders, moderate kyphosis, long, moderate lumbar lordosis, *increased pelvic* tilt, no overcarriage

ually others become more angulated downward as shingles on a roof so that the sixth and seventh are almost flat. From this point, they again become more vertical until in the lumbar region they are longer and thinner as well as more prominent This fact makes possible the "flat back." The normal dorsal convexity is



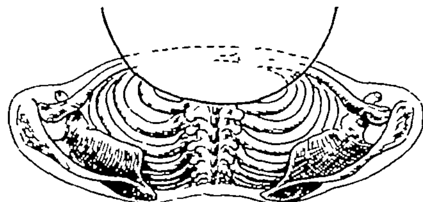


Figure 53 Good Position of head and shoulders.

most prominent at the level of the seventh or eighth dorsal verte bra where the spinous processes are almost flat. The lumbar spinous processes are longest at the level of the third lumbar ver tebra and gradually become shorter at the fourth and fifth lumbar level. In good posture therefore the back has practically no convexity between the first dorsal and the fifth lumbar vertebrae.

The lumbar curve or lordosis is produced by the angulation of the sacrum as well as the prominence of the buttocks A string stretched from the first dorsal vertebra to the fifth lumbar vertebra should be straight in the lateral view It should just touch the



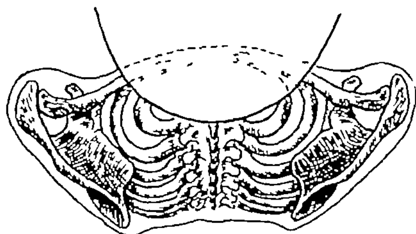


Figure 54. Forward position of head and shoulders.

spinous processes from the first dorsal to the fifth lumbar zone. In the dorsal region, a very slight prominence in the region of the fourth thoracic vertebra is very common as the spinous process of this vertebra is inclined to point less strongly downward than the fifth and succeeding vertebrae Occasionally the fourth

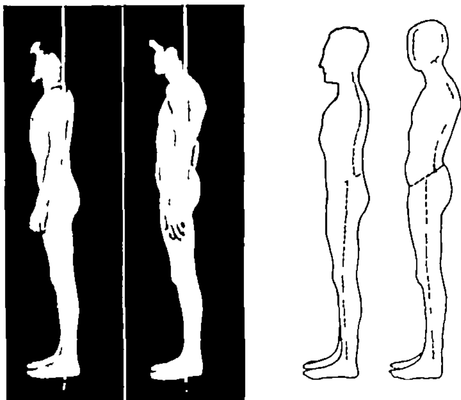


Figure 55. Left photograph and drawing—Excellent Posture. Right photograph and drawing—Poor Posture Marked forward shoulders and neck, marked kyphosis, moderate lordosis and increased pelvic tilt, abdomen chest mild defect though no overcarriage

spinous process will press against the taut string in good "flat backs" but in general, the string will just touch them all

A first degree increase in the dorsal kyphosis is one in which there is a slight bulging of the taut string. In a second degree increase the bulge is greater Several degrees of increased kyphosis may be determined and serve as ratings. The lumbar curve in first degree increases will pull away from the string so that perhaps one finger can be passed under the string at the point where the curve attains its maximum depth. A second degree increase will permit two or three fingers to be passed beneath the string The third increases are roughly two to four inches deep at their farthest point from the string

Determinations of the forward tilt of the pelvis are very difficult to make. The structure of the pelvis its irregular shape and angles make such determinations difficult. A marked forward tilt of the pelvis is occasionally possible even though the dorsal and lumbar curves may be practically minimal.

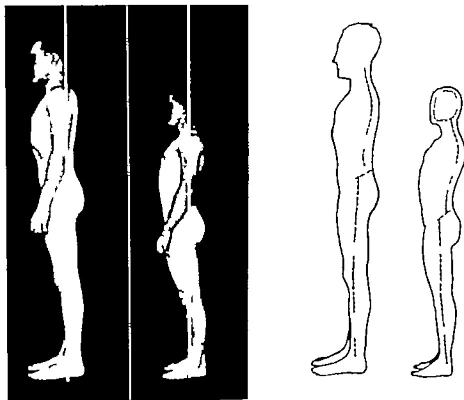


Figure 56 **Left photograph and drawing**—Excellent Posture. **Right photograph and drawing**—Exaggerated Posture. Mild kyphosis, over corrected neck, shoulders good, marked lumbar lordosis, marked overcarriage.

In a few individuals the lumbodorsal junction may show a kyphosis This is found in slumped, relaxed individuals whose pelvis has rolled upward more than normally and whose abdomen bulges forward. Such a slumped posture is difficult to correct. The term "reverse curve" is used as a brief and convenient way of describing the condition. This condition may also be encountered in highly flexible individuals who have been overcorrected.

Reversed curve is a condition which can be very easily brought about in corrective work with children and must be watched for carefully in any exercise programme

Increased pelvic tilt is usually a part of the increased lumbar lordosis It does not necessarily vary in direct proportion with the amount of lordosis as measured by the taut string as above because it may be due to a marked increase in the lower part of the curve It is, however always associated with a change in the abdominal line It must be estimated in much the same manner that the neck position is estimated. An increased pelvic tilt will cause a prominence of the lower part of the abdomen as well as an increased prominence of the buttocks The line of the upper part of the buttocks tends to parallel that of the lower part of the abdomen and it is by means of these two more or less parallel lines, that the amount of pelvic tilt can be determined. In the normal position of the pelvis the bony ring of the brim of the true pelvis is placed so as to form an angle of 60 to 65 degrees with the ground on which we stand. In this position the lines of the lower abdomen and the buttocks tend to be parallel

**Overcarriage.** The iliofemoral or "Y" ligament, when longer than normal, either congenitally or otherwise will allow a greater amount of hyperextension at the hip causing a postural defect termed "overcarriage" Thus overcarriage may be defined as a position in stance characterized by three points 1) The legs instead of being perpendicular or nearly perpendicular when viewed in profile are definitely tilted forward. 2) There is no increase in the upward rolling of the pelvis 3) The trunk is inclined backwards from the perpendicular The part of the body farthest forward is the lower abdomen and pelvic brim This postural defect could not be simulated were the "Y" ligament short, because the legs would bring down the front of the pelvis, thus increasing the lordosis which in turn would be compensated for by an increased dorsal kyphosis. Then the neck would be held in a forward position. Overcarriage, a fairly common postural defect, is usually found in individuals with long or slack ligamentous parts Back knee, hyperextensible elbows, fingers,

Determinations of the forward tilt of the pelvis are very difficult to make The structure of the pelvis its irregular shape and angles make such determinations difficult. A marked forward tilt of the pelvis is occasionally possible even though the dorsal and lumbar curves may be practically minimal.

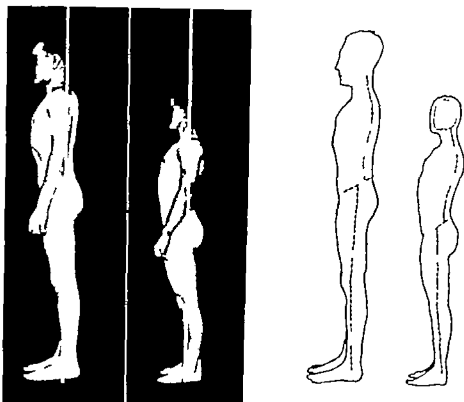


Figure 58 **Left photograph and drawing**—Excellent Posture **Right photograph and drawing**—Exaggerated Posture Mild kyphosis, over cor rected neck, shoulders good, marked lumbar lordosis, marked overcarriage.

In a few individuals the lumbodorsal junction may show a kyphosis This is found in slumped, relaxed individuals, whose pelvis has rolled upward more than normally and whose abdomen bulges forward. Such a slumped posture is difficult to correct. The term "reverse curve" is used as a brief and convenient way of describing the condition This condition may also be encoun tered in highly flexible individuals who have been overcorrected.

Reversed curve is a condition which can be very easily brought about in corrective work with children and must be watched for carefully in any exercise programme

Increased pelvic tilt is usually a part of the increased lumbar lordosis. It does not necessarily vary in direct proportion with the amount of lordosis as measured by the taut string as above because it may be due to a marked increase in the lower part of the curve It is however always associated with a change in the abdominal line It must be estimated in much the same manner that the neck position is estimated An increased pelvic tilt will cause a prominence of the lower part of the abdomen as well as an increased prominence of the buttocks The line of the upper part of the buttocks tends to parallel that of the lower part of the abdomen and it is by means of these two more or less parallel lines that the amount of pelvic tilt can be determined In the normal position of the pelvis, the bony ring of the brim of the true pelvis is placed so as to form an angle of 60 to 65 degrees with the ground on which we stand In this position the lines of the lower abdomen and the buttocks tend to be parallel

Overcarriage The iliofemoral or "Y" ligament, when longer than normal, either congenitally or otherwise will allow a greater amount of hyperextension at the hip causing a postural defect termed "overcarriage" Thus overcarriage may be defined as a position in stance characterized by three points. 1) The legs, instead of being perpendicular or nearly perpendicular when viewed in profile are definitely tilted forward 2) There is no increase in the upward rolling of the pelvis. 3) The trunk is inclined backwards from the perpendicular The part of the body farthest forward is the lower abdomen and pelvic brim. This postural defect could not be simulated, were the "Y" ligament short, because the legs would bring down the front of the pelvis thus increasing the lordosis which in turn would be compensated for by an increased dorsal kyphosis. Then the neck would be held in a forward position. Overcarriage a fairly common postural defect, is usually found in individuals with long or slack ligamentous parts. Back knee hyperextensible elbows, fingers,

and thumbs may accompany overcarriage because these "slack jointed" individuals are of such a particular body build.

**Abdominal Varieties of Posture.** Numerous as these may be, there are usually a number who show good muscular tension indicated by a nearly flat line, in the lateral view from the symphysis to the xiphoid The fat person has a lower bulge, some-

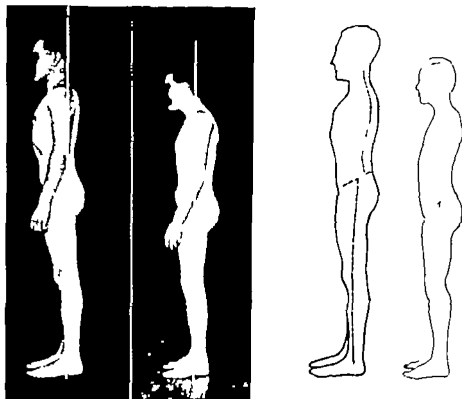


Figure 57 **Left photograph and drawing**—Excellent Posture. **Right photograph and drawing**—Poor Posture. *Normal lordosis, shoulders, pelvic tilt, abdomen, chest and no overcarriage but head and neck too far forward.*

times drooping over the symphysis whereas the average body build may have an upper abdominal protuberance Children have prominent, bulging abdomens Pre-adolescents are flat bellied Those with a round back show lowered ribs an increase in lumbar lordosis and a slack abdominal wall. This has been noted also in those showing an *overcarriage*

Classifications may be determined as follows First degree prominence when only a slight increase is seen second degree prominence when the abdomen is definitely prominent and third degree when there is a marked bulge In cases where the prominence is especially low or high, this fact should be noted.

**Flat Chest.** Variations of the thorax usually are correlated with variations in the dorsal spine With the rise and fall of the chest in respiratory excursions the intercostal muscles act chiefly without producing changes in the dorsal spine because the ribs articulate with the vertebral components From the position of complete expiration it is difficult to breathe with the diaphragm alone, because of the drag downwards on the viscera. In this position, the capacity of the chest is so diminished that aeration of the lungs is not complete The position of full inspiration, on the other hand, is difficult to assume because of the tension on the intercostals and accessory muscles of respiration. This strained position cannot be maintained in an easy standing or sitting normal attitude. Therefore as regards the chest alone the examiner must decide whether it is being held in a position nearer the mid point between expiration and inspiration, or whether it is in the position of more or less full expiration. Variations associated with a flat chest, are a forward neck and a prominent abdomen.

**Hip Flexion.** This deformity is usually observed accompanied by a forward tilting of the pelvis If an unusual extent is suspected, the Thomas test will determine the degree Such a test is as follows The subject is placed in the supine position on a flat surface The knee of one leg is brought up and flexed until the thigh makes contact with the abdomen and chest. This rotates the pelvis upward until the lumber spine comes in contact with the surface of the table throughout its entire length If the leg is then held by the individual s hand in this position and it is still possible for the other leg to be completely extended and in contact with the table, there is no flexion deformity If on the other hand, the extended leg comes up from the table, there is a flexion deformity present and it can be measured in terms of the angle

made by the extended thigh with the horizontal. Hip flexion deformities are not common, however except in structural disorders.

**Knee Postures.** Lack of complete extension is uncommon. Hyperextension beyond the line of gravity or *back knee* should be noted, if present, and the heel cords carefully examined for possible shortening. Such shortening of the heel cords is the most common cause of hyperextension at the knee. If the heel cords are of normal length slack jointedness may be present.

**Feet.** Standing, with the body weight balanced on two feet, placed about four inches apart and slightly divergent, is accomplished effortlessly in normal posture. Balance is maintained by slight variations in muscular actions around the ankles as has been described in Chapter V

**Pronation.** Greatest source of discomfort leading to a postural disturbance is that of flat feet, "fallen arches" or "weak ankle postures." Actually these conditions are all due in a large part to pronation a disturbance which varies in degree only and is observed in the position of the heels as seen by the examiner from behind. If marked, the inner border of the foot may make full contact with the ground and the heels *cant* outwardly at an angle of 60 to 70 degrees. Usually the heel cord is long or slack and the individual may seem to toe out. The opposite stance may be observed, wherein the foot is inwardly rotated and the heel shows a tilting away from the center of gravity This movement in both instances is in the subtalar joint except in gross muscular weakness as in poliomyelitis when the pronation may take place at the ankle joint as well Foot prints are useful in recording these disorders of foot posture. A varus or valgus deformity may be caused by a number of diseased conditions

Metatarsal lengths should assume the proportions described by Morton (1952) When the first toe is shorter or more lax in its ligamentous structures an instability will exist. This is noted by the examiner and must not be mistaken for simple pronation Hypermobility of the first metatarsal unit is a weakening element

in older feet. In youth no symptoms may be present because of greater resistance to strain, but later such a foot may weaken Harris and Beath(1949) from a Canadian Army Foot Survey contradict this concept reporting that no weakness should follow a short or hypermobile first metatarsal unit Morton(1952) believes their ideas were based on standing foot impressions whereas in locomotor studies the opposite concept should be apparent. In this sense, it is expedient for an examiner of postural conditions to have the individual stand first on one foot and then the other simulating locomotion in part, yet not actually walking out of place. This dynamic aspect of foot posture will then become clearer and disturbances of stance can be determined more readily

**Callosities.** There may be a large callous under the heads of one or more metatarsals Such a callous has been pointed to as indicative of a dropped metatarsal arch. Actually there is no metatarsal arch. The weight is borne on all five heads with the first assuming double that of the remaining four X ray studies and foot prints will clearly determine this dynamic stance Such a callous indicates faulty weight bearing, the result of a short first metatarsal or of improper shoes or socks When calloused areas are found on the extensor surfaces of the toes the shoes are always to blame being either too small or improperly made so too much pressure is applied on the toes Hammer toes usually have dorsal callosities for the same obvious reasons.

**Toe Nails.** Anomalous nails are rather infrequent but shoe pressures may cause inflammatory nail margins Following crushing injuries new nails are frequently very thick and hard. They need special trimming When fungus infections are present nail margins are the sites of painful redundant areas leading to "ingrown" nails. Trim nails straight across for greatest comfort. Since we must wear shoes, as a cultural perquisite feet will suffer unless cared for assiduously

**Lateral Deviations of the Spine.** These abnormalities are classified under scoliosis or spinal curvatures. The two great divisions

are functional scoliosis and structural scoliosis. In general, *functional scoliosis* may be defined as a rotary lateral curvature of the spine which a flexible and normal spine may assume when it is bending to the left or right of the line of gravity. *Structural scoliosis* may be defined as a rotary lateral curvature resulting in a position which cannot be assumed by the normal spine.

In a functional scoliosis, there is no alteration in shape of the

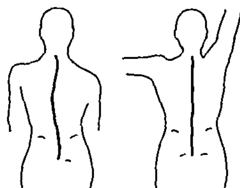


Figure 58 Key-note Position of Roth. Left—Dorso-rotary scoliosis. Is this a functional or a structural curve? Right—by raising the right extremity high over the head, and the left abducted to ninety degrees from the body the scoliosis is correctable. Thus it is a functional type

vertebral ligaments or trunk muscles. Hanging from an overhead bar by the hands will permit complete realignment to take place. However, a functional scoliosis may be produced by a structural change elsewhere, such as a shortening of one leg in poliomyelitis. This type of scoliosis may be simulated by placing a book under one foot of a normal individual.

Structural scoliosis, on the other hand, shows a change of shape of the bones, length of the ligaments and strength of the muscles of the trunk. These may be congenital in character or acquired as the result of a disease or injury. A long standing functional scoliosis may produce irreversible changes and develop into a structural curvature. Growth factors of unknown variabilities may



Figure 59 A short leg can also produce a functional scoliosis. A book, placed under one foot, illustrates the mechanism

be dominant causes of scoliosis in the adolescent individual

The mechanism of balance tends to keep the body erect In order to prevent falling the line of gravity is kept as near the center of the base of support as possible Since the body is flexible rather solid there is always present the tendency to counterbalance an increased load on one part of the body by shifting the load in another part although not necessarily by shifting the body as a whole Thus when standing in the erect position if one arm is extended laterally there is a deviation of the body as a whole to the opposite side but also the spine curves laterally toward the side of the extended arm and tends to throw the weight of the head and upper thorax to the opposite side To quote Lovett "Every step every raising of the arm tilting of the head is accompanied by a deviation of the spine from the median plane of the body in other words by a temporary lateral curve which disappears as the symmetrical attitude is resumed" Recently the act of locomotion has been indicated as the chief cause of scoliosis Faulty locomotion can produce scoliosis It is therefore of the utmost importance to be certain that the body as a whole is in a symmetrically balanced position when undertaking the examination

There are many other correlations of importance among which are visual errors hearing difficulties, wryneck, right and left handedness a short leg muscular defects or deficiencies in the

arms or legs as well as the trunk, abnormalities of development of the bones or soft parts, habitual occupational postures, and neurological disorders

Curves are always described, relative to their convex side as right or left, referring always to the right or left side of the patient when looking at their back. A total or "C" curve is one which involves the whole length of the spine and is all in one direction. A double or "S" curve is one in which there are two curves present, one in one direction and the other in the opposite. Occasionally a triple curve is seen. Curves are named after the part or parts of the spine which they involve, such as cervical, cervicodorsal, dorsal, dorsolumbar and lumbar The double curves are described as right dorsal, left lumbar or left cervicodorsal, right dorsolumbar The upper curve is always named first The curves are judged by a string stretched from the seventh cervical to the fifth lumbar spinous process The string is not hung as a plumb line from the seventh cervical, since many individuals normally deviate the whole body to one side or to the other and a false impression would be gained. But if the taut string is stretched from the seventh cervical to the fifth lumbar then the curve can be determined. If all of the curve lies to one side of the string, it is a single or "C" curve If part lies to one side and part to the other it is an "S" curve. The approximate amount of the curve can be determined by measuring the distance between the spinous process and the taut string where this distance is greatest, and naming the spinous process Thus an individual curve may be described as an "S" curve, right cervicodorsal one-half inch at the second dorsal and left lumbar one-quarter inch at the second lumbar Such measurements are fairly accurate. The list of the entire trunk can be determined by suspending the plumb line from the tip of the seventh cervical spinous process and noting how far to the left or right it falls from the cleft between the buttocks

Most cases of functional scoliosis are left total or "C" curves This curve can be produced experimentally in the normal individual by placing a book under the right foot. The left shoulder will be higher and farther forward than the right. The right hip

will appear more prominent than the left The right side of the back will be slightly more prominent than the left and the left side of the thorax will be slightly more prominent than the right. That is, there will be a rotation of the body towards the right side. Any deviation from this picture in a left scoliosis should cause the examiner to suspect a structural change Thus if the

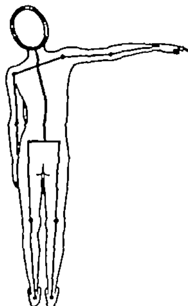



Figure 60 Functional scoliosis produced by raising arm from side

right shoulder is higher or forward if the left hip is more prominent, if the rotation is in the opposite direction, or if the curve is an "S" curve, the case should be further examined for structural changes

In a fat individual the creases over the hips are not of equal depth even with a very slight degree of scoliosis. In thinner individuals this is less apparent. Rotation is always present. A plastic or non-rigid weight bearing column, already curved in one plane cannot yield in another plane without twisting, and so twisting the vertebrae can turn in only one direction, namely away from the greatest weight or pressure. This is therefore

always directed toward the concave side of the lateral curvature.

In most young adults who may show a scoliosis or deviation of the spine, so that symmetry is lost, a functional cause is operating. Correction is largely individual. Bowen, revised by Stone (1953) quotes Roth in the use of "key note positions" for cor-

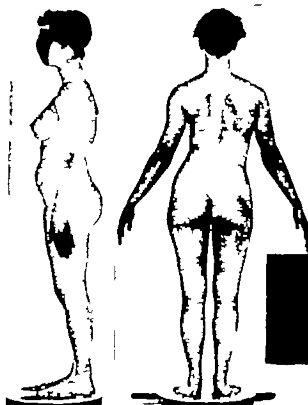


Figure 61 A Structural Scoliosis. Partial correction and fusion have restored good posture.

recting these functional, flexible curves. The individual tries to stand as correctly as possible. If for example, in assuming this position, a convex thoracic left curve is present, raising the right arm to the proper height may bring into action certain muscles, which will straighten the spine. Sometimes raising both arms over head or stepping a half pace to the right or left and rotating the spine may be the key position of correction. This is then assumed as frequently as possible together with a dynamic, over correction

exercise Proper exercises never correct structural scoliosis but may aid in compensating by added muscular strength. What is intended in this regard is exemplified by the congenital type, caused by a single hemivertebra. Such a curve never grows greater It grows longer at both ends and compensatory curves above and below are strengthened by muscle exercising, so that the individual is usually healthy and well enough balanced though not symmetrical.

Summary For examination purposes the individual must stand erect, at ease, having removed all clothing shoes and socks. Occasionally limited shorts are worn but not advisedly The feet may be parallel four inches apart or with the heels near together and the toes pointing outwardly Never should the position of a soldier at rigid attention be assumed Eyes are held on the level and directed straight ahead. Nothing is held in either hand. Wrists and fingers are straight, in prolongation with the forearm, elbows extended, to give the pose a *modicum of dynamic reality*

The examiner should then stand three or four feet behind and observe the symmetry of the hips, level of the backs of the knees and shoulders, being sure the head is not tilted to either side and that the weight is borne equally on two feet. Ankles should be noted to ascertain the degree of pronation of both feet. If there is pronation on one foot and not in the other a slight scoliosis may develop Any asymmetry should be assayed, such as a high left shoulder prominent right hip rotation in terms of prominence of the right or left side of the thorax. The length of the legs should be noted, as regards the level of the backs of the knees The direction of the gluteal folds and creases below the gluteus maximus on the thighs should be rated. If the individual is fat, the creases above the hips may be great. A string should then be stretched from the seventh cervical to the fifth lumbar region and the spinous processes palpated beneath it Any deviation from the line of the string should be noted. The spinous processes are not always directly over one another Occasionally one may be tilted laterally A scoliosis can be differentiated from such a condition by the palpation of the spinous processes of the

vertebrae directly above and below the one out of line. If these are in line, then there is no scoliosis

If a scoliosis is present, it should be noted on the examination blank as to the type direction of and amount of curve at its greatest distance from the string and the vertebra at which the curve is maximal. If the curve is a "C" type, it is classified as functional. Compensatory curves are noted. Leg measurements are taken If the findings are not in agreement with those necessary for a functional scoliosis the curve should be considered structural and causes determined X rays should be used whenever feasible. In these, as in other structural variations treatment should always be individually directed under the guidance of the orthopedist.

Backknees, hip flexion deformities overcarriage and other misalignments are rated Knock knees, pronated feet, depressed chest, protruding abdomen and chin may be observed and given the necessary attention they deserve All ratings are recorded for comparing at a later date

CHAPTER VII

# POSTURE IN PHYSICAL EDUCATION

THE FIELD of physical education includes procedures which may be classified as corrective educational hygienic, and recreative in character A corrective program consists of instructions and exercises which promote good posture by eliminating faulty mechanical relations of bodily parts An educational program also develops motor skills as related to form and function, making greater coordination possible in achieving nerve-muscle control of the body In the hygienic field, exercises should be aimed at stimulating body vigor through superior circulatory respiratory and alimentary efficiency The recreative program consists of activities which take the individual out of himself and relate him to a group through posture building games and team play

The older "orders" used a set plan, a drill, a lesson containing marching, military exercises, free gymnastics exercises with light apparatus heavy apparatus, dances and games With the exception of games, all of these activities were subjective in nature, wherein the attention of the individual was directed to himself Complete subjectivity however was not achieved owing to the presence of an instructor who always occupied a prominent part in the lesson and toward whom a great deal of attention was directed Whether or not this confusion of objective and subjective aims failed to maintain interest and spontaneity is not generally appreciated. These older gymnastic techniques nevertheless have been given up in most institutions in this country and abroad, where many of them were first taught.

In the meantime there has developed a tremendous interest in competitive athletics, sports games and organized play Facilities and equipment for these activities have grown to such an extent that nearly everyone can participate. The interest and spontaneity in this new development stems from the fact that the individual

is lifted out of himself and his attention is directed toward some external object. This emphasis in a physical education program has paid dividends beyond expectations

Attention has been paid to posture by including a number of elements which increase mechanical proficiency of positions and movements of the body essentially known as "dynamic posture." Participation in games embodies all manner of postures. As these are related to the individual, a greater need of knowledge, related to the efficient use of the body has become a fundamental pre-



Figure 62. Use of Stature Measuring Stand to Demonstrate Bad and Good Posture.

requisite in all fields of athletics sports games and for children through organized play This is carried over into everyday activities so that the participants have profited immensely

The old gymnastic systems used corrective exercises but their results were less effective Participants had little knowledge of correct body posture or the physical means of achieving it. Subjective effects emphasized muscle development and gross strength, and results were measured by increased girths and strength tests. The ideal of good posture was portrayed in the artificial military stance The chest was lifted the chin retracted with a resultant taut abdomen and usually a strained back. The knees were "back set" and the feet turned out at an angle of 60 degrees This position was fatiguing and could only be maintained during part of the gymnastic lesson Mass athletic drills and extravaganzas were the usual thing In Germany and Russia these reached their peak.

Although corrective values in physical education have always been stressed by means of old admonitions, such as "stand up" "carry your head up" "lift up your chest," and the like these had little meaning unless the additional knowledge of correct posture and body mechanics was understood. Then and only then was there a carry-over in daily living instead of being simply a half hour gymnastic lesson as was formerly the case. In such ways physical education justifies its existence. Young men and women athletes should be made as conscious of correct poise and body actions as they were once conscious of achieving a tremendous set of muscles. The emphasis should be placed on line and function rather than on muscle mass Strength will follow

In the field of physical education considerable concern has been raised by the indictment recently proposed by Krause and Hirschland (1954) They have evaluated groups of normal children and young adults relative to their degrees of strength for trunk and hamstring muscles as well as general flexibility Their tests have been conducted in low back clinics and public schools here and abroad. They present provocative evidence, concluding that American children, and subsequently adults are far behind their European counterparts They attribute these differences to our highly "mechanized society" wherein we are transported every

where, to school and to business in buses cars elevators and trains These labor saving devices deny us and our children the necessary exercises required to keep our postural muscles strong and our bodies flexible There can be no doubt of the validity of their claims To remedy the situation, albeit their sometime pessimism, they suggest that "muscular fitness tests" should be a part of every school health examination and that greater partici pation programs should be expanded at all school levels In daily living, these exercise outlets are urgently needed for relief of nervous tension, a malady of our American culture.

In some of the earlier methods of teaching posture, different bodily parts were strengthened without any idea of the posture as a whole. Thus exercises might be given for strengthening the pelvic and/or shoulder girdle without any idea of body poise. This proved of little value unless the two were coordinated. For example, if the abdominal and gluteal muscles were exercised but did not work together as rotators of the pelvis such an exercise to relieve excessive lumbar lordosis would be useless In exercises about the shoulder girdle, the posterior scapular muscles, the rhomboids and lower trapezius if not particularly coordinated, the upper trapezius will do most of the work and so defeat the purpose of the exercise by permitting the vertebral border of the scapula to stand out away from the ribs Individual muscle training should be emphasized first, so that individual muscle actions may be isolated and later coordinated with special group movements. This type of control must be developed to the highest degree in teach ing special skills in the objective phases of physical education, as well as in all postural corrective classes.

**Corrective Program.** The time to start corrective exercises is in the pre adolescent period and these may of course be carried over very effectively into the young adult period.

A corrective program may be built around three phases of activities *First* the introduction of the general scope of the planned action *Secondly* a review of the findings of the orthopedic examination and *thirdly* the organization and teaching of the exercise system should be carefully coordinated by all concerned

**General Scope** In outlining the general plan of the proposed work, the importance of ease and efficiency of movement, in relation to general health should be emphasized. The subjective method vs. the objective method of teaching should be explained showing that once the correct knowledge of body structures and movements are understood and learned, it becomes a part of the individual in his everyday life, whether in work or play An appreciation of body mechanics in relation to athletics and daily living, should be emphasized. The pupil should also be reminded of the possibilities of faulty posture during resting periods whether standing, sitting or lying Standing at ease does not necessarily mean slumping nor does sitting mean half lying

**Personal Interview** The defects revealed by the orthopedic examiner are then discussed with the individual, in terms that can be easily understood. In this instance the four photographs taken during the general examination at Yale University are invaluable. Measurements and relations are pointed out that are good and emphasis is placed on those that lend themselves to correction. Visual aids of this sort are useful in all physical educational efforts A goal is described to the individual toward which everyone concerned will strive This is the moment of considerable importance to the physical educator Here, he or she may make or break the entire program Motivation is necessarily an imperative point to develop Hidden ideas within the individual's mind may be brought to light. Much good can be done if sufficient time is devoted to this type of interview

**Systematic Teaching.** The third phase deals with the organization and teaching of the exercise system It is often necessary to work with groups because time and personnel do not permit individual instructions. However groups should be small so that the quality of instruction may simulate individual standards as closely as possible.

**Good Posture Groups.** Postural instructions are advisable even for those individuals having good posture as this will often prevent the development of defects. The preventive group is usually

small. In teaching this group general over-all developmental exer cises are needed, plus instructions related to body mechanics and good posture

**Poor Posture Groups.** The first group would include cases with poor tendencies expressed in mild or first degree defects, especially those with a single defect such as a first degree *neck forward* position or first degree *overcarriage* in the absence of any other defect.

The second group always the largest, includes second degree defects of kyphosis lordosis and scoliosis with at least a one-half inch list.

The third group includes third degree defects of all types.

**Group Size.** The maximum number of subjects in a class should not exceed twenty for the preventive group sixteen for the first and second corrective groups and six for the third because of the amount of individual attention usually desirable

**Exercise Program** Usually consisting of at least three lessons a week of thirty minutes each. Such a program may well be designed as has been that used at Yale for a considerable time with some success.

The room in which the class meets should be well ventilated and lighted It should be free from other activity interference so that the entire attention of the students may be devoted to their exercises The equipment necessary should include mirrors, pads or mats for the exercises done on the floor and the mirrors full length and movable so that observations are possible of the back, side and front of a student. A loin cloth or short tights should be worn All muscle actions and body alignments should be keenly watched. The range of motion of the shoulder joints should be judged at this time, since inability to raise the arms fully may result in disturbance of body alignment as has been described. Faulty positions of standing, sitting and lying are pointed out and their correction described. The correct sitting position instead of the half lying or slouching position is empha

sized. The lower back should always make contact with the back of the chair in sitting

An instructor should correlate all exercises and positions of the body with activities of everyday life Such a dynamic approach to posture building insures rapid learning For example in movements such as forward bending the abdomen should be retracted and the lower back flexed simultaneously as the lungs are emptied by exhalation just as one bends to pick up a light weight object from the floor If the object is heavy the knees are bent in the same act of flexing the spine When raising the arms overhead, there should be a coordinated lifting of the abdominal muscles together with deep inspiration and flattening of the lumbar spine, as in the act of reaching overhead toward a high shelf

During all body movements muscles act reciprocally For every effort in a given direction produced by muscles contracting there is a reciprocal contraction of apposing muscles in order to maintain coordination and control For example in bending backward the lumbar spinal muscles contract together with the abdominals The latter control the movement while the former muscles are the active motors

Whenever there is a weakness and lengthening of a group of muscles there will be found a tightness and shortening of a reciprocal group In this respect an exaggerated lumbar lordosis usually has an accompanying overstretched and weak abdominal muscle component. By the same token a dorsal kyphosis will usually have overstretched spinal muscles and contracted anterior shoulder musculature Sometimes the abdominals are likewise weak and the hips are slightly flexed. In overcarriage alone they are stretched and weak. Here the gluteal muscles are apt to be contracted. Such exercises as are here applicable may be classified as stretching and strengthening in character When combined with coordinating exercises poise may be expected. Good posture is best achieved through well integrated instructions that correct individual defects by stretching and strengthening exercises.

Stimulating exercises leading to body poise are combined with the necessary corrective types of movements so that a dynamic

posture a readiness is the end result. Tension is reduced by freely swinging, rhythmical motions of the body repeated in sequence. Standing, sitting, walking and running are taught in good order each by means of selective efforts well timed and coordinated. For example the instructor should describe the exercises about to be performed. Each individual will then carry out these specific movements slowly and at the command of the instructor The rhythm can be counted out by the participants led by the instructor Individual timing may be encouraged and soon each exerciser can be allowed to proceed on his own In this manner easy fluid and graceful movements are achieved and good posture is assured.

CHAPTER VIII

# CORRECTIVE EXERCISES FOR STRENGTHENING



Figure 63 Exercise One

*Sitting trunk bending forward.* For trunk and back leg stretching in flexion.

*Position* Sitting with legs flat and trunk at right angles to the floor neck firm with elbows well back and shoulder blades well ad ducted.

*Movement.* Bend and pull trunk forward as far as possible-then slowly raise trunk to starting position The knees should not be lifted at any time. On forward and downward bending, back should be evenly curved its entire length. In trunk raising, the movement should start in the lower back with abdomen well retracted, and travel upward along the spine until the erect position is reached. A tendency to lean beyond a right angle should be prevented.

A slight disposition to reverse the lumbar curve when in a sitting position is illustrated.

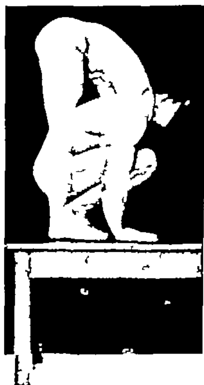
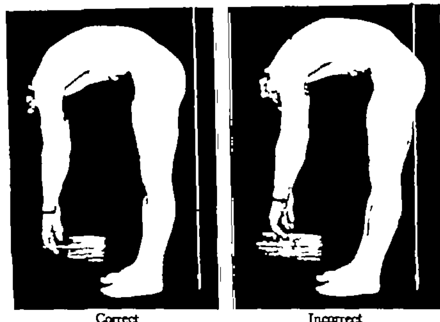


Figure 64. Exercise Two.

*Squat rest knee stretching and trunk bending* For trunk and back leg stretching in flexion, similar to Exercise One

*Position* Squat rest with knees together palms flat on the floor and wrists near toes.

*Movement* Stretch knees to straight leg position, retracting the abdomen, pushing out the lumbar spine and flexing the head and neck. There should be an even curve from hips to head and the weight should be pushed forward onto palms. Many individuals cannot attain the final position of this exercise with the wrists near toes as illustrated.



Correct Incorrect

Figure 65 Exercise Three

*Standing, trunk forward bending* For trunk stretching in flexion.

*Position* Fundamental standing position.

*Movement* Slowly bend trunk forward and downward retracting abdomen and contracting the buttocks. To make this exercise most effective, keep the legs as nearly perpendicular as possible. Do not allow hips to move backward as illustrated. In raising trunk, start from base of spine and slowly move upward, assuming fundamental position while maintaining retraction of the abdominals and contraction of the gluteals.

Lack of flexibility of back of a subject with lordosis is illustrated. If the weight is carried back as illustrated, the greater part of flexion occurs in the dorsal spine.



Figure 68 Exercise Four

*Sitting trunk twisting.* For trunk flexibility

*Position* Sitting, neck firm with feet spread. Chest high and elbows well back.

*Movement* Slowly twist trunk as far as possible to the right or left, keeping head erect, elbows well back, and the trunk at right angles to floor at all times. If the movement is done alternately right and left, there should be a decided pause at the starting position to prevent a slovenly swing from side to side. The subject illustrated has relaxed too much in the lower back and abdomen.



Figure 67 Exercise Five.

*Kneeling* on hands and knees, trunk lifting and sinking. For trunk stretching in flexion.

*Position* Kneeling with hands and knees on the floor trunk relaxed.

*Movement* Slowly lift back to a well rounded curve retracting abdomen, flexing head sharply on the chest. Relax slowly returning to starting position.



Figure 68 Exercise Six.

*Kneeling crouch. back stretching.* For shoulder and dorsal spine stretching in extension.

*Position* Kneel, then sit on heels with forehead on the floor arms extended over head, back well rounded.

*Movement* Push forward until thighs are perpendicular to floor keeping forehead and chest as low as possible and arms fully extended. Abdomen should be well retracted in returning to starting position.

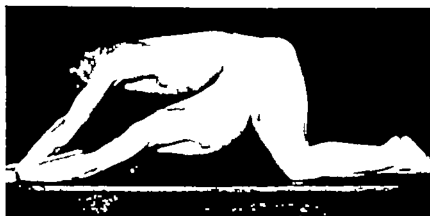
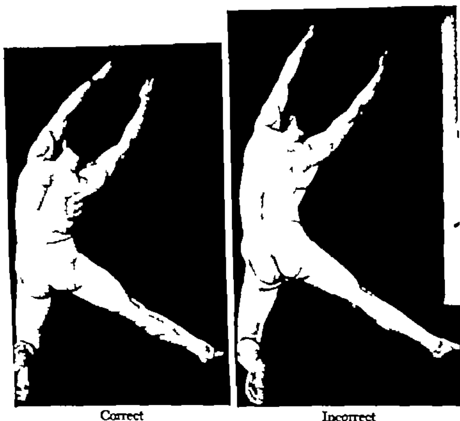


Figure 69 Exercise Seven.

Same as Exercise 6 except the start is made from the kneeling position with thighs perpendicular to floor as illustrated. There is no sliding forward but instead the shoulders and thorax are dropped, allowing arms to fully extend.



Correct Incorrect

Figure 70 Exercise Eight.

*Kneeling trunk bending.* For lateral trunk and intercostal stretching.

*Position* Kneel on the left knee with the right leg extended sideward. Trunk is erect with arms extended over head. Abdomen is retracted and buttocks contracted.

Movement Bend trunk sideward toward the extended leg without relaxing at waist. Lift ribs on the high side, stretching upward. Hold the lower trunk firmly with no twisting and keep arms well extended with elbows straight. Execute exercise to both sides, left and right.




Figure 71 Exercise Nine.

*Sitting back stretching* For overcorrection of dorsal and lumbar curves

*Position* Sitting with knees drawn up and spread, with soles of feet together arms are passed between knees grasping ankles from the outside. Keep head and trunk erect.

*Movement*-Pull shoulder blades together as far as possible against resistance offered by the grasp on ankles, keeping shoulder girdle well down. Trunk should always be erect or a little forward of perpendicular In long armed individuals, grasp should be sufficiently forward on the foot to maintain a perpendicular position. The pull thus effected should reverse the dorsal curve while the sitting position, with knees flexed, reverses the lumbar curve. This exercise is most effective in cases of marked kyphosis and lordosis but should never be used with children and hyperflexible individuals.

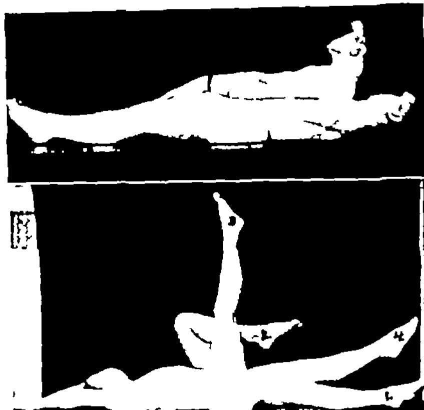


Figure 72. (Upper) Exercise Ten.

*Lying on back: trunk raising* For abdominal strengthening.

*Position.* Lying on back with arms down at sides or resting on thighs.

*Movement* Slowly raise trunk high enough to lift shoulders off floor rounding the upper back. Slowly unroll to the starting position. Gluteal contraction should be maintained throughout. This exercise can also be carried out from the "neck firm" position.

In progression, the trunk can be raised to half sitting (45 degrees) and full sitting (90 degrees) position. When reaching a full sitting position trunk is erect and not rounded.

Figure 73 (Lower) Exercise Eleven.

*Lying on back knee raising, leg sinking.* For strengthening abdominals and gluteals.

*Position.* Lying on back with arms along thighs or extended over head, neck firm.

*Movement* Fully flex the knee and thigh on abdomen. With thigh still flexed, extend the leg to a perpendicular position with abdominals and gluteals fully contracted to fix pelvis. Then gradually lower leg to the starting position. In the illustration, (1) indicates starting and finishing positions (2) the fully flexed knee (3) a perpendicular position, and (4) the descending leg.



Figure 74. Exercise Twelve.

*Sitting knee raising.* For strengthening abdominal muscles.

*Position.* Sitting with legs flat and trunk erect. Hands may be placed on floor back of hips for support, (1) hips firm as illustrated, (2) neck firm, or (3) extended over head. These positions are taken progressively

*Movement* From starting position flex hip and knee as fully as possible without changing position of trunk. Return to starting position as illustrated. Exercise should be done with one leg at a time, followed by both legs together At first foot may rest on floor throughout exercise but later should be elevated as strength permits

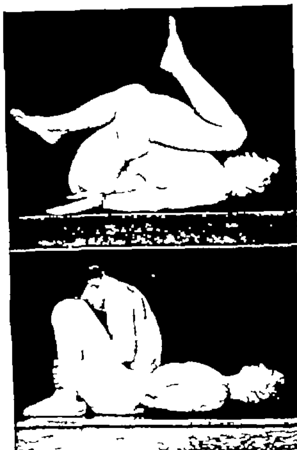


Figure 75. (Upper) Exercise Thirteen.

*Lying on back: lumbar spine flexion.* For intensive abdominal muscle strengthening.

*Position.* Lying on back with arms at side and spread a few inches from thighs. Knees and thighs are flexed on abdomen.

*Movement.* Draw knees to point of chin, keeping head on the floor. Keep heels as close to buttocks as possible. Do not carry knees beyond chin because such action would take the load from the abdominal muscles.

Figure 76. (Lower) Exercise Fourteen.

*Lying on back with knees flexed.* trunk raising. For abdominal strengthening and lumbar stretching.

*Position.* Lying on back with knees drawn up, feet on floor and heels close to buttocks, arms at side or over head.

*Movement.* With a free swing of arms, raise trunk to a sitting position bringing forehead to knees, hand grasping ankles, legs or knees. Free grasp and return to starting position. Grasp can be fixed throughout as illustrated, if the proportions of arms and trunk permit.



Figure 77 Exercise Fifteen

*Lying face down* Arm, leg and chest raising for back strengthening.

*Position* Face down, legs together with toes pointed, arms at sides neck firm, or over head to meet exercise requirements.

*Movement* A great many movements may be executed from this position. With arms over head, raise one or both arms as illustrated. With arms at sides, hips firm raise one or both legs Then combine single and double arm and leg raisings with arms over head. In progression, trunk raising can be done with hands on hips neck firm, as in illustration, or with arms over head. If there is a tendency to increased lordosis, the lower back should be flattened by gluteal contraction and abdominal retraction.

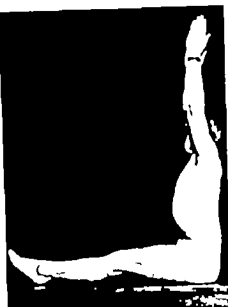


Figure 78. Exercise Sixteen.

*Sitting position:* Arm stretching and bending. For upper back strengthening.

*Position* Sitting, with trunk at right angles to floor abdomen retracted, head erect and hands on hips.

*Movement* Slowly raise arms laterally then bend elbows to neck firm position and slowly stretch arms over head as illustrated. Return in reverse order Maintain a low position of shoulder girdle throughout movement.

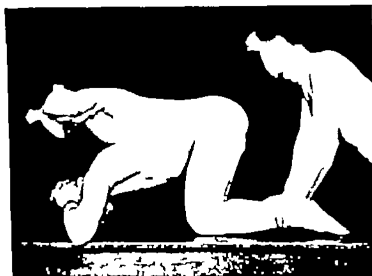


Figure 79 Exercise Seventeen.

*Trunk raising in kneeling position with support* For back strengthening.

*Position* Kneel, with thighs at right angles to floor neck firm and trunk bent forward, with forehead resting on the floor

*Movement* Raise trunk to a position parallel to floor shoulder blades well adducted and thighs perpendicular head erect.



Figure 80 Exercise Eighteen.

*Lumbar flattening with pelvic rotation.*

*Position* Active standing.

*Movement* Because this exercise may be difficult for a beginner the instructor may assist the subject as in the illustration, placing one hand on the buttocks, and the other on abdomen with head against upper back to keep the trunk in line. The buttocks are drawn together and depressed while the abdominals are contracted, especially the lower components. Then assist adduction of the shoulder blades without raising the shoulder girdle while keeping arms straight down the middle line of the body After the release command, abdominals and gluteals should be allowed to relax. Hand and head of the instructor should remain in place allowing maintenance of the essential position. Every effort should be made to keep the subject from relaxing or slumping with completion of exercise. A general tendency for subject to contract upper part of the abdominal muscles, as shown in the illustration, should be avoided.




Figure 81 Exercise Nineteen.

Same as Exercise 18 without the assistance of instructor but with wall support.

*Position.* Standing with back touching wall and heels several inches removed.

*Movement* Same as in Exercise 18

Illustration shows correct position, but with two common faults (1) feet are toeing out instead of being parallel, and (2) head is carried too far forward. Illustration shows extremely relaxed position without wall support.

Without Training | Voluntary Attempts to Improve | Without Training

Figure 82. Exercise Twenty

Same as Exercise 18 in free standing position.

*It might be well at this point to consider some of the faulty positions* usually met with when teaching lumbar flattening and shoulder blade adduction, generally considered the basis of all postural training.

Illustrations are those of a previously untrained subject during the first lesson. 1) Normal standing position of subject. 2) Subject's own idea of correct posture. 3) Attempting to carry out lumbar flattening. This has resulted in an incorrect use of upper trunk muscles bringing into



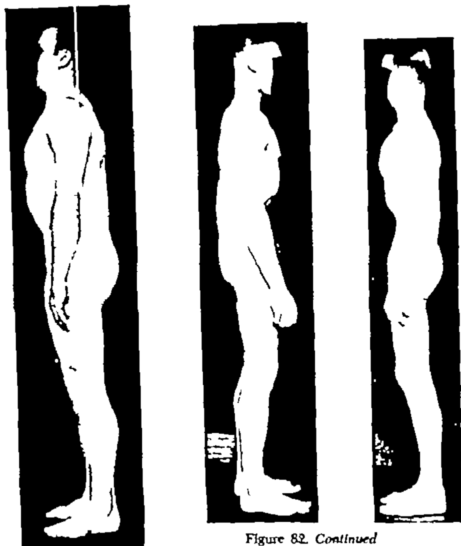


Figure 82. *Continued*

contraction upper abdominals, internal intercostals and pectorals as well as the sternocleidomastoid muscles and the platysma, resulting in a rounded back. Correction of upper back disorder by means of shoulder blade adduction and relaxation of upper trunk muscles is observed. The same sequence in a younger subject is demonstrated. 1) Normal standing position. Illustration shows the subject's attempt to carry out the lumbar flattening with faulty results as noted above 2) Correction of upper back difficulty by means of shoulder blade adduction and relaxation of the upper trunk muscles has developed a strained position The Body is fairly well balanced but shoulder girdle is lifted too high and neck muscles are too rigidly contracted.



Figure 83

In addition bad reverse curves in the lumbar region, as a result of extreme abdominal and gluteal contractions, are noted. Such individuals must be handled singly never in groups.



Figure 84. Exercise Twenty-one.

*Pelvic flattening in prone lying position* For co-ordinating pelvic and shoulder girdle corrections.

*Position.* Prone lying, hips firm, neck firm or arms extended over head.

*Movement* Contract abdominal and gluteals to flatten lumbar spine, as in the standing position. If subject shows an increased dorsal kyphosis as is illustrated, the shoulder blades should be ad ducted with neck firm. *This exercise is one that is particularly* helpful where there is a lack of flexibility

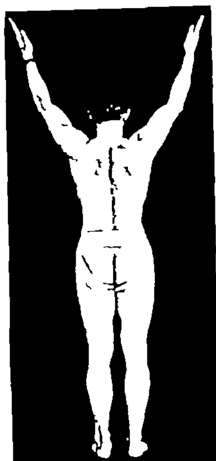


Figure 85 Exercise Twenty-two.

*Arm raising over head for scapular muscle and shoulder girdle control.*

*Position.* Fundamental standing.

*Movement:* Slowly raise arms forward over head and lower sideward and downward. In raising arms the body alignment should not be changed, nor should shoulder girdle be lifted. This is a common error in all arm raisings. In lowering arms sideward and downward, they should be drawn downward from between the shoulder blades, using those muscles which depress and adduct the shoulder blades, the inferior trapezius and rhomboids. Great care should be taken in these exercises to maintain the pelvic girdle in a correct position as described in lumbar flattening exercises, allowing no forward thrust of the pelvis and thighs

Arm exercises may also be carried out in positions such as sideward or forward raising, and they may be combined with stretching and bending from the neck firm position.

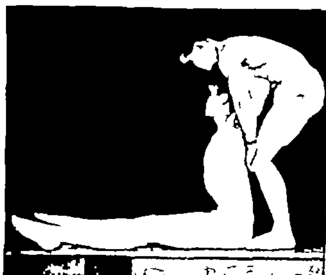


Figure 85a.

If disease factors in the shoulder joints have been excluded during the physical examination, limitation of motion can be attributed to muscle binding or ligamentous tightness and stretching can be carried out by means of the following exercises. With subject in a sitting position, legs flat, trunk erect, neck firm, the instructor applies pressure with the knees to the dorsal region of the spine and at the same time draws backward as illustrated. The subject must be cautioned not to resist this stretching but instead to assist by lifting head and drawing back shoulder blades.



Figure 86 Exercise Twenty-three

A second exercise is carried out with the subject in a supine position, knees and hips flexed as fully as possible to flatten the lumbar spine. Arms are extended over head and stretching results from pressure downward on the elbows. An inability of the subject in the latter exercise to touch arms to the floor indicates an increased lumbar curve. The same apparent difficulty would be present when a mechanical obstruction is caused by an increased dorsal kyphosis.

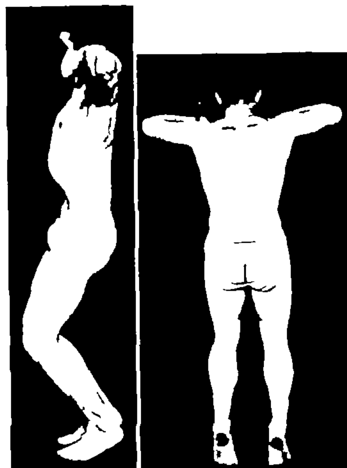


Figure 87 Exercise Twenty four

*Heel raising and knee bending* Exercise for increasing skill in balancing.

*Position* Fundamental standing.

*Movement* Contract gluteals and abdominals and adduct shoulder blades Raise heels and slowly bend knees. This exercise should be carried out in half knee bend position and later with increased skill, should be carried out from a full knee bend. The thigh adductors should be forcibly contracted to keep legs in alignment and to prevent an outward bending at the ankles At no time, particularly on heel raising and lowering, should the gluteals or abdominals be relaxed. Trunk should be held in correct position with shoulder blades adducted.

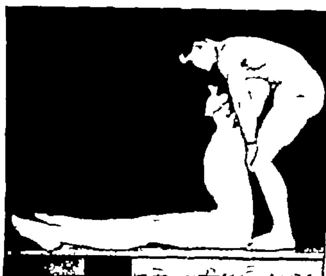


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Figure 86. Exercise Twenty three.

A second exercise is carried out with the subject in a supine position, knees and hips flexed as fully as possible to flatten the lumbar spine. Arms are extended over head and stretching results from pressure downward on the elbows An inability of the subject in the latter exercise to touch arms to the floor indicates an increased lumbar curve. The same apparent difficulty would be present when a mechanical obstruction is caused by an increased dorsal kyphosis.



Figure 87 Exercise Twenty four

*Heel raising and knee bending.* Exercise for increasing skill in balancing.

*Position* Fundamental standing.

*Movement* Contract gluteals and abdominals and adduct shoulder blades. Raise heels and slowly bend knees. This exercise should be carried out in half knee bend position and later with increased skill, should be carried out from a full knee bend. The thigh adductors should be forcibly contracted to keep legs in alignment and to prevent an outward bending at the ankles. At no time particularly on heel raising and lowering, should the gluteals or abdominals be relaxed. Trunk should be held in correct position with shoulder blades adducted.

CHAPTER IX

# SUMMATIONS

DOUBTLESS the human upright carriage of man's body has been derived from the horizontal posture of the ancient quadruped. This vertical adaptation began as a mutation, probably during the early half of the period during which the primate stock came into being. The prehuman and other anthropoidal units diverged from an earlier stem. Some postural features therefore, associated with an erect carriage of the body were consequently inherited in part by the other anthropoids, the gibbon, orangutan, chimpanzee and the gorilla. These compare with man in many anatomical and physiological adaptations yet man's posture and locomotion is distinct and unique. This rapid adaptation of man to his environment represents an example of Simpson's "quantum evolution."

Many factors have aided in this process. For example, the development of a "sight brain" (binocular vision) from a "smell brain" greatly enlarged cerebral hemispheres automatic functioning of the cerebellum determining postural reflex habits, preadaptations stemming from primate arboreal life and greater efficiency of muscular power for maintaining the erect position by an increase in size and position of function of the gluteus maximus and the erector spinae. Man stood erect with a good brain free hands coordinated to his eyes capable of calculated movements for survival. It is what man did with this successful arboreal adaptation, when he became a terrestrial biped, that counted most. He has been a success because of later cultural developments subsequent to his permissive evolutionary origins.

Environmental factors influencing man's posture, with their adaptations and dispositions are related internally to physical growth and externally to special activities conditioned by his cultural demands. These are further directed by the individual's

inherited body matrix with its many growth patterns operating on plastic dynamic structures to produce numerous varieties of normal.

Wolff's law defines the structure of bone in the adult as related to internal and external architectural stresses Body size is controlled by the law of squares and cubes in which the size of a bone is determined by the weight it must support Thus a femur whose surface area is the square of man's femur will support a weight that is the cube of man's weight. This explains the relatively small size of the bones of a gorilla compared to the great weight they are able to carry about. On the other hand, man is unique among the primates in possessing more bone per muscular unit. This is probably demanded by his erect posture for stability purposes.

Growth and development of the individual begins within a fluid medium contained by the uterus The resistant yet elastic walls and the organ's shape influence the foetal position of flexion. A long convexly curved body results with an uncoiling, so to speak, taking place at birth Gravity then begins to play an active part in the infant's posture.

During the first year of life the child may be influenced considerably by its position relative to the horizontal surface on which it must rest. Extensor muscles of the neck back and thighs are more responsive and quite strong This difference in muscle power greatly conditions the infant's postural capacities A slack abdominalis for example usually made worse by overfeeding of liquid food, leads to a slower sitting time and later retards standing erect.

Postural reflexes play an important part, as exemplified in the early clutch or grasp of the hands and feet, lost after a few months unless the child is mentally defective Reflexly reaching for the flat surface when lowered from above and the abduction, adduction movements of the hallux are autonomic reactions, together with the Babinski which are usually lost at one year of age. In this regard, upper extremity reflexes are usually lost at an early age while other reflexes of the lower extremities are retained for postural purposes Thus the cerebellum continues its

reflex controls throughout life while the cerebrum retains only a few

When the child has sufficient strength to support its own head it will sit up. The long spinal curve, open anteriorly is soon altered to include a slight lumbar lordosis on standing Rapid development (strengthening) of the gluteal, the erector spinae and the hamstrings muscles aids in these mechanical adjustments. Bowed legs knock knees and slack heel cords may be normal variants of lower extremity postures and are of little significance unless marked in degree.

Thus normally early childhood is punctuated by a prominent abdomen, slight lumbar lordosis a convex upper back and less than full extension of the knees and hips A child may begin to roll his pelvis upward and forward Feet are often relaxed, as are other bodily structures thought to be so because of the latent hormonal effect from maternal sources Mild foot pronation, associated with slack heel cords and an apparent "double jointed ness" may persist normally only to diminish under the demands of use. Clothing may have a limited effect, but the diaper is usually innocuous Internal tibial torsion may persist for a time.

Pre-school aged children must be well shod and stockings should be large enough The abdominal relaxation of early child hood may persist in some degree and should not be treated with a support. It will usually correct itself Selected wheeled toys are useful. Relaxed feet are usually self correcting elements, unless real deformations are present. These latter need orthopedic wedging of inner heel margins.

The middle childhood period, between six and ten years of age, marks the time when individual body types assert themselves. Sexes develop equally with the girl child more refined texturally The sizes and dispositions of parts are similar with the girl child beginning to grow heavier and taller earlier Knees are now fully extended when standing but not when running The lumbar lordosis increases and the abdomen may still be prominent. The chest is flat and the ribs held down because of the pull of the abdominalis The dorsal spine is straighter though the shoulders may appear rounded. Pronation is less An increased general

activity takes place with growth Flexibility is great. Decelera tion of growth in this age group should lead the physician to suspect some disorder

Pre-adolescence is characterized by greater growth in stature and weight of the female child Coordination increases and while the male child seems to be more clumsy at this time he actually is less so Close study indicates greater skills are present relative to body movements. *He is only more self conscious and shows it* through awkwardness Corrective exercises are the most effective at this period. Deterioration of growth centers may make their appearance preceded by a deceleration of growth.

Adolescence shows greater variations related to internal environmental influences Girls decelerate in statural growth and develop feminine proportions Boys grow for two to four more years and masculinize (muscularize) at individual rates These rates need careful study so that fatigue, so commonly present, need not be a destructive agent. Exercises games and particularly contact sports require great selective participation Slow ma turing youths should be greatly restricted by alert, aware coaches and physicians This is a time when severe strains and sprains are commonly encountered. Other elements are similar to those of earlier age groups with however a diminishing of back and lower extremity flexibility predominating Growth of the latter is proceeding at a very rapid rate.

The young adult is the individual end result of all that has gone before for better or for worse If the latter corrective exercises for positioning, increased power of muscles and skills in body movements are very effective Programs of educational institutions should be carried on throughout this time zone of opportunity This is the moment of greatest physical and sexual activity Both may be channeled better if intelligent supervision is permissive.

Normal posture is difficult to define because of the dynamic aspects, too often forgotten It is a fluid state an absence of strain a near relaxation in the erect stance, that permits graceful movements with the least expenditure of energy This includes more strenuous physical efforts and is hence a corollary of locomotion. Man s bipedal stance can be effectively accomplished only if

energy is saved in the doing thereof He learns the trick through "a natural experimental method." A chimpanzee never learns to run in the erect position. Dogs do so rarely with a tremendous effort. A child does not accomplish coordinated locomotor habits for running well until at least the age of three Some reports indicate a necessary learning period of seven years

Other definitions of *normal posture* are suggested, but each investigator may invent his own. Psychobiologists have contributed an interesting concept, suggesting that posture is a species (man) adjustment, including attitudes of position, coordinated with behaviors In this monograph "normal posture" is defined by the authors as the average or mean of a large number of postural studies made under the circumstances On the other hand "normal posture" for the individual as opposed to the group normal, is the position assumed habitually by the individual. This determination starts with the feet and is related to the most efficient position for knees hips back, shoulders and head. It varies with body types The army series of anthropometric photographs, together with numerous other studies are the sources of the authors ratings of normal posture. These posture concepts are probably valid but are also indicative of the need for better methods of preparation and training

The mean posture of man is not ideal by any means. Ideal posture is only observed in the trained individual. Cultural factors definitely contribute elements toward achieving posture. For example the abolition of child labor in the western world has reduced fatigue in pre adolescence. Well organized sports programs are very effective. Compulsory education to an older age, usually until growth has ceased, has given opportunities for physical education that pays tremendous dividends Man s posture should become better each decade, modern inventions of transportation to the contrary notwithstanding The opportunities of developing good posture exist, needing only greater exponents of training programs coordinated with the parent, the child, the institution and the educator Methods of accomplishing these worthy ends are proposed, including special exercises.

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# INDEX

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This Book

THE DIAGNOSIS AND TREATMENT
OF POSTURAL DEFECTS
*(Second Edition)*

*By*

WINTHROP M. PHELPS, M.D., ROBERT J. H. KIPHUTH,
M.P.E., and CHARLES W. GOFF, M.D.

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